Errata

Title & Document Type: **1345A Digital Display Operating and Service Manual**

Manual Part Number: **01345-90915**

Revision Date: **March 1985**

About this Manual

We've added this manual to the Agilent website in an effort to help you support your product. This manual provides the best information we could find. It may be incomplete or contain dated information, and the scan quality may not be ideal. If we find a better copy in the future, we will add it to the Agilent website.

HP References in this Manual

This manual may contain references to HP or Hewlett-Packard. Please note that Hewlett-Packard's former test and measurement, life sciences, and chemical analysis businesses are now part of Agilent Technologies. The HP XXXX referred to in this document is now the Agilent XXXX. For example, model number HP8648A is now model number Agilent 8648A. We have made no changes to this manual copy.

Support for Your Product

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Search for the model number of this product, and the resulting product page will guide you to any available information. Our service centers may be able to perform calibration if no repair parts are needed, but no other support from Agilent is available.

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SECTION I

GENERAL INFORMATION

1-1. INTRODUCTION.

1-2. This Operating and Service Manual contains information required to install, operate, test, adjust, and service the HP Model 1345A Digital Display.

1-3. Listed on the title page of this manual is a Microfiche part number. This number can be used to order 4- by 6-inch microfilm transparencies of the manual. Each microfiche contains up to 96 photoduplicates of the manual pages. The microfiche package also includes the latest Manual Changes supplement.

1-4. SPECIFICATIONS.

1-5. Instrument specifications are listed in table 1-1. These specifications are the performance standards or limits against which the instrument is tested. Table 1-3 lists supplemental characteristics. Supplemental characteristics are not specifications but are typical characteristics included as additional information for the user.

1-6. SAFETY CONSIDERATIONS.

WARNING

To prevent personal injury, observe all safety precautions and warnings stated on the instrument and in this manual.

1-7. This product is a Safety Class 1 instrument. Review the instrument and manual for safety markings and instructions before operation. Specific warnings, cautions, and instructions are placed wherever applicable throughout this manual. Refer to the Safety Summary in the front of this manual and to Sections II, V, and VIII for further safety precautions. These precautions must be observed during all phases of operation, service, and repair of this instrument. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standard of design, manufacture, and intended use of this instrument. Hewlett-Packard assumes no liability for the customer's failure to comply with these requirements.

1-8. INSTRUMENTS COVERED BY MANUAL.

1-9. Attached to the instrument is a serial number tag. The serial number is in the form: 0000A00000. It is in two parts; the first four digits and the letter are the serial prefix, and the last five digits are the suffix. The prefix is the same for all identical instruments. The suffix, however, is assigned sequentially and is different for each instrument. The contents of this manual apply to instruments with the serial number prefix(es) listed under SERIAL NUMBERS on the title page.

1-10. An instrument manufactured after the printing of this manual may have a serial number prefix that is not listed on the title page. This unlisted serial number prefix indicates that the instrument is different from those described in this manual. The manual for this newer instrument is accompanied by a Manual Changes supplement. This supplement contains "change information" that explains how to adapt the manual to the newer instrument.

1-11. In addition to change information, the supplement may contain information for correcting errors in the manual. To keep this manual as current and accurate as possible, Hewlett-Packard recommends that you periodically request the latest Manual Changes supplement. The supplement for this manual is identified with the manual print date and part number, both of which appear on the manual title page. Complimentary copies of the supplement are available from Hewlett-Packard.

1-12. For information concerning a serial number prefix that is not listed on the title page or in the Manual Changes supplement, contact your nearest Hewlett-Packard office.

1-13. DESCRIPTION.

1-14. The Hewlett-Packard Model 1345A is a 15.24 cm (6 in.) Display Component. It produces vector graphics on its display screen in response to digital commands from a user processor. Because of its high resolution (2048 x 2048 addressable points), the 1345A can draw both straight and curved lines (curvilinear vectors). Curved lines can be accomplished by a series of short straight vectors. The 1345A draws all vectors in a picture by moving its display beam at the same speed. This constant writing rate ensures a picture of uniform brightness (short vectors do not become brighter than long vectors). Erasing a waveform that intersects other waveforms (vectors) will not leave blank spaces at the intersections. At its faster drawing rate, and at 60 Hz refresh rate, the 1345A can draw a picture that contains up to 3226 inches of vectors. If the refresh rate is slowed to 40 Hz (possible in some applications), then the picture can contain up to 4838 inches of vectors. For labeling or identification of soft-key functions, the 1345A has a built-in set of ASCII characters. The 1345A receives just one word from the user processor and all the vectors necessary to form the character are automatically produced.

Table 1-1. Specifications

INTERFACE

General: 16-bit TTL binary with 2-wire handshake (Option 704: 3-wire handshake), unterminated.
Connector: 26-pin male Ansley type 609-2627.
Recommended Mating Connector: 26-pin female Ansley type 609-2630 with strain relief Ansley type 609-2631. Recommended cable length ≤ 2 feet. (Note: See Option 325 for mating data cables).

ANALOG OUTPUTS

General: X, Y, and Z analog signals to drive a slave CRT display.
Amplitude: approximately 1V p-p open circuit.
Output Impedance:
X,Y: 340 ohms nominal.
Z: 250 ohms nominal.
Polarity:
X — Positive-going voltage corresponds to right beam movement.
Y — Positive-going voltage corresponds to upward beam movement.
Z — Positive-going voltage corresponds to increasing luminance.
Recommended bandwidth of slave display:
X,Y Axis: ≥ 3 MHz
Z Axis: ≥ 10 MHz
Recommended mating connector: Molex 22-01-1023 (See option 323 for factory supplied X-Y-Z output cables)

DISPLAYED IMAGE

Image Size: Factory adjusted to approximately 8.5 cm (3.35 in.) vertically by 11.5 cm (4.53 in.) horizontally.
Resolution: Addressable; 2048 by 2048.
Visible (shrinking raster): ≤196 lines vertically by 266 lines horizontally (full scale).
Geometric distortion: ≤ 2.4 mm error in addressing any location within the image area due to geometric distortions and nonlinearity in CRT and stroke generator.
Repeatability: ≤ 0.5 mm position variation in re-addressing any point.
Refresh rate (Option 704): approximately 60 Hz for displayed images containing up to 2000 vectors each 3.3 cm long and 100 characters, at maximum programmable writing speed (approximately 0.5 cm/μsec).
Phosphor: P31 (green).

POWER REQUIREMENTS

Operating Voltages		Max P-P Ripple	Max Current	
Voltage	Tolerance		Standard	Option 704
+15VDC	±5%	10mV	1.05A	1.05A
-15VDC	±5%	10mV	0.3A	0.3A
+5VDC	+5 -0%	50mV	0.75A	1.8A

Recommended Mating Connector: AMP type 1-350234-9

Note: See Option 323 for mating power cable.

Table 1-2. 1345A Functions

GRAPHIC FUNCTIONS

CHARACTERS

Character Sets: 128 Character ANSI ASCII Set 0
HP 9825/9826 Special Keyboard Symbols
Sizes: Four Sizes;

Sizes	Characters/Line	No of Lines	Character Size	
			Graphic Units	MM(approx)
1.0X	56	28	24 X 36	1.3 X 1.5
1.5X	37	18	36 X 54	2.0 X 2.2
2.0X	28	14	48 X 72	2.6 X 3.0
2.5X	22	11	60 X 90	3.3 X 3.7

Table 1-2. 1345A Functions (Cont'd)

Orientations: 0, 90, 180, 270 degrees CCW relative to horizontal

VECTORS

Line Types:
Solid Line
Solid line with intensified end points
Short dashed line
Long dashed line
Dots at end points only

Velocity:
Four Beam Velocities:
approximately 0.13 cm/μsec
approximately 0.25 cm/μsec
approximately 0.38 cm/μsec
approximately 0.51 cm/μsec

Brightness: Three visible brightness levels plus blank (beam off). Maximum brightness is approximately 170 cd/m^2 at slowest programmable writing speed (approximately 0.13 cm/μsec and 60 Hz refresh rate).

PLOTTING

Plotting Modes: Plot absolute and Graph

Beam Control: The beam may be turned on or off while plotting.

GRAPH GENERATION

Tick Marks: X- and Y-axis tick marks of four selectable lengths.

Graph Mode: Allows generation of graphs which have a constant X-increment between points by storing the X-increment once, requiring only new values for succeeding points.

SELF TEST

Self Test is invoked by disconnecting the I/O connector with power applied. The Test Pattern verifies that the 1345A is fully operational and provides necessary stimulus for routine calibration. Alternate Test Pattern, invoked by internal jumper change, verifies performance specifications and allows calibration of focus and astigmatism adjustments.

Table 1-3. Supplemental Characteristics

OPERATING ENVIRONMENT

Temperature: (operating) 0° C to +65° C (+32° F to +149° F)

NOTE

The 65° C (+149° F) temperature specification reflects the maximum allowable operating temperature with the 1345A enclosed, not the ambient temperature of the system housing. It is recommended that a minimum of 0.28m^3/min (10 ft^3/min) of air flow is forced around the instrument to ensure that the maximum operating temperature of 65° C (+149° F) is not exeeded.

Temperature (non-operating): −40° C to +75° C (−40° F to +167° F).

Humidity: to 95% relative humidity up to +40° C (+104° F).

Altitude: (operating) to 4600 m, (15,000 ft.); (non-operating) to 15,300 m, (50,000 ft.).

Shock: 30 G peak level with 11 ms duration and 1/2 sinewave shape.

Vibration: vibrated in three planes for 15 min. each with 0.38 mm (.01 in.) excursion, 10 to 55 Hz.

Dimensions: Refer to outline drawing Figure 1-8.

Weight: Net: approximately 4.4kg. (10 lb).

Shipping: approximately 5.8kg. (13 lb).

Bezel: Compatible with HP 197B camera equipped with 10375A adapter (order 197B option 006).

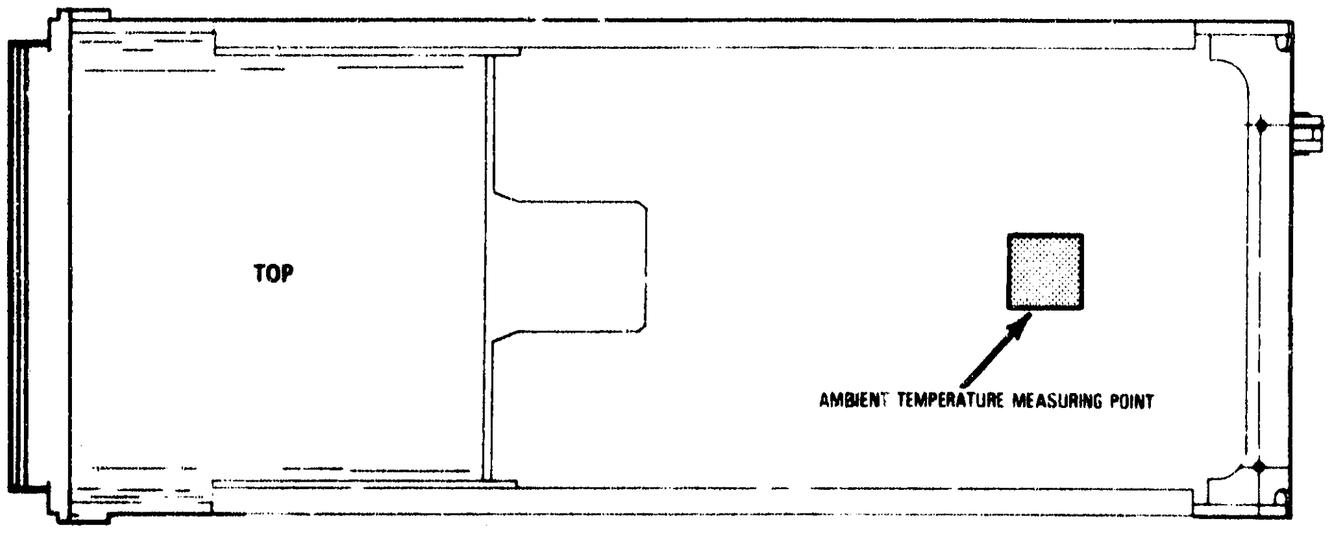


Figure 1-2. Ambient Temperature Measurement

1-15. ACCESSORIES SUPPLIED.

1-16. The following accessories are supplied with the 1345A:

One Operating and Service Manual.

1-17. OPTIONS.

1-18. Standard options are modifications installed on HP instruments at the factory and are available on request. Table 1-4 lists available options for the 1345A.

1-19. OPTION 001.

1-20. Option 001 provides all the necessary materials for external Focus and Intensity control. The cables between the Stroke Generator Board and the Focus and Intensity pots are 60.9 cm (24 in.) long.

1-21. Focus and intensity may be controlled from the front panel if external controls are added. Connectors are provided on the Stroke Generator Board (A1) for adding the controls. The External Intensity Control potentiometer should have a value of 1K ohm and the Focus Control potentiometer should have a value of 5K ohms. The potentiometers should have a tolerance of no greater than 10%, should be linear tapered and a wattage rating of ≥ 1 W. The external control connections should be made according to the schematics in figures 1-4 and 1-5.

Table 1-4. Standard Options

Option	Description
001	Provides external Focus and Intensity controls, P/N 01345-69501.
323	This option supplies X-Y-Z output cables for an external display. The cables are 61 cm (24 in.) long, P/N 01345-69502.
325	Provides a dc power input cable and an I/O interface cable. The cables are 91.5 cm (36 in.) long, P/N 01345-69503.
500	This option deletes Operating and Service manual.
564	Provides a blue contrast filter in place of the standard neutral density filter.
704	This option adds 4K x 16-bit Vector Memory (see Service Sheet 6).
910	This option provides an extra Operating and Service Manual.

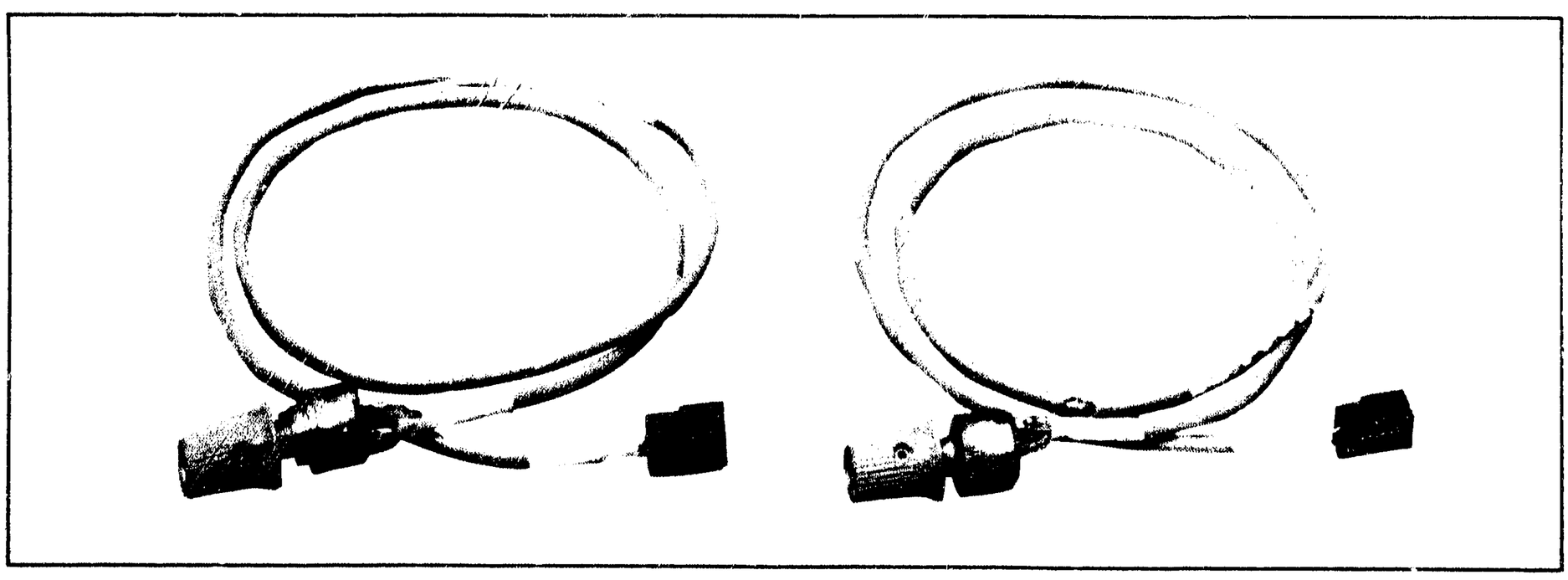


Figure 1-3. Option 001 Cable Detail

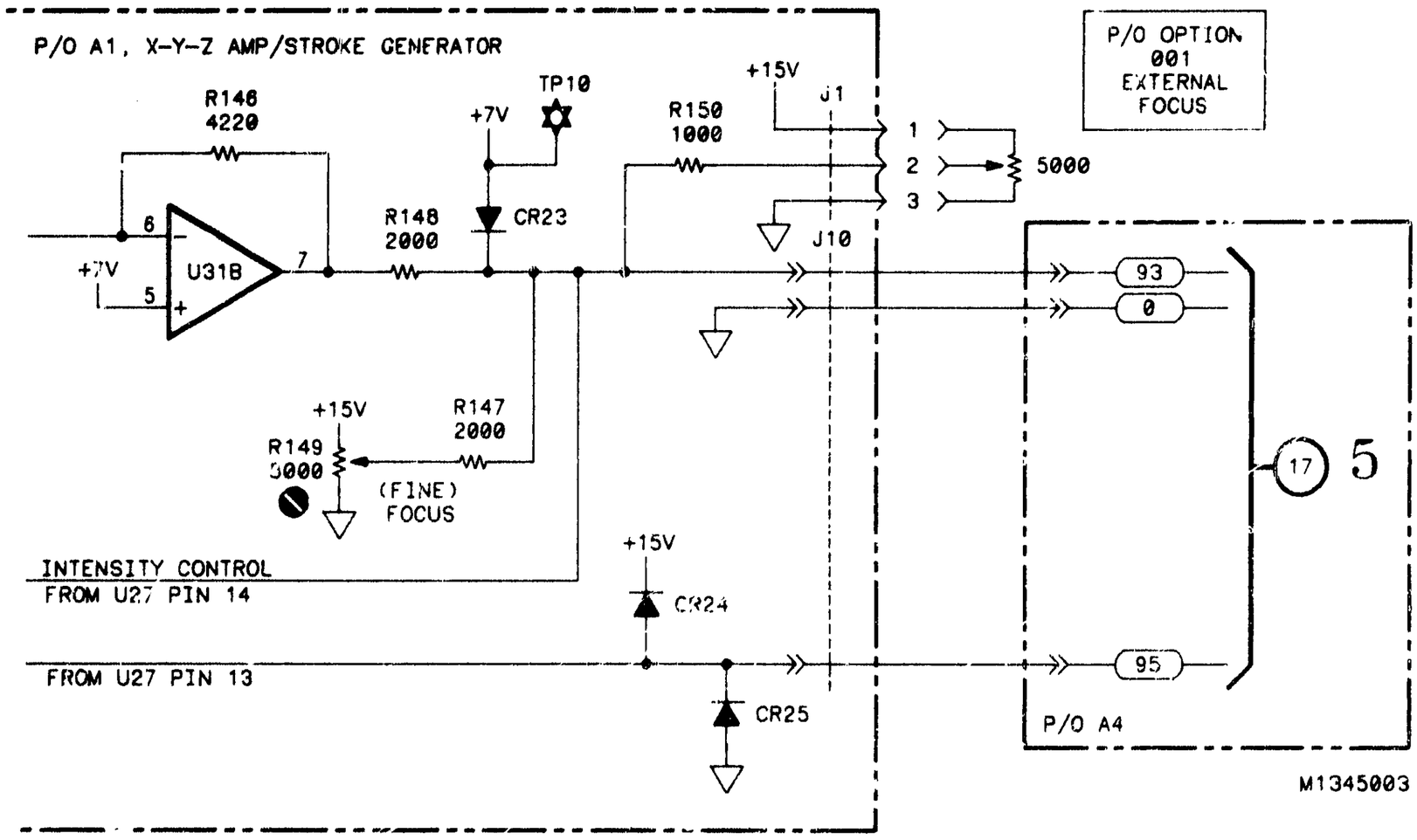


Figure 1-4. External Focus Potentiometer Connection.

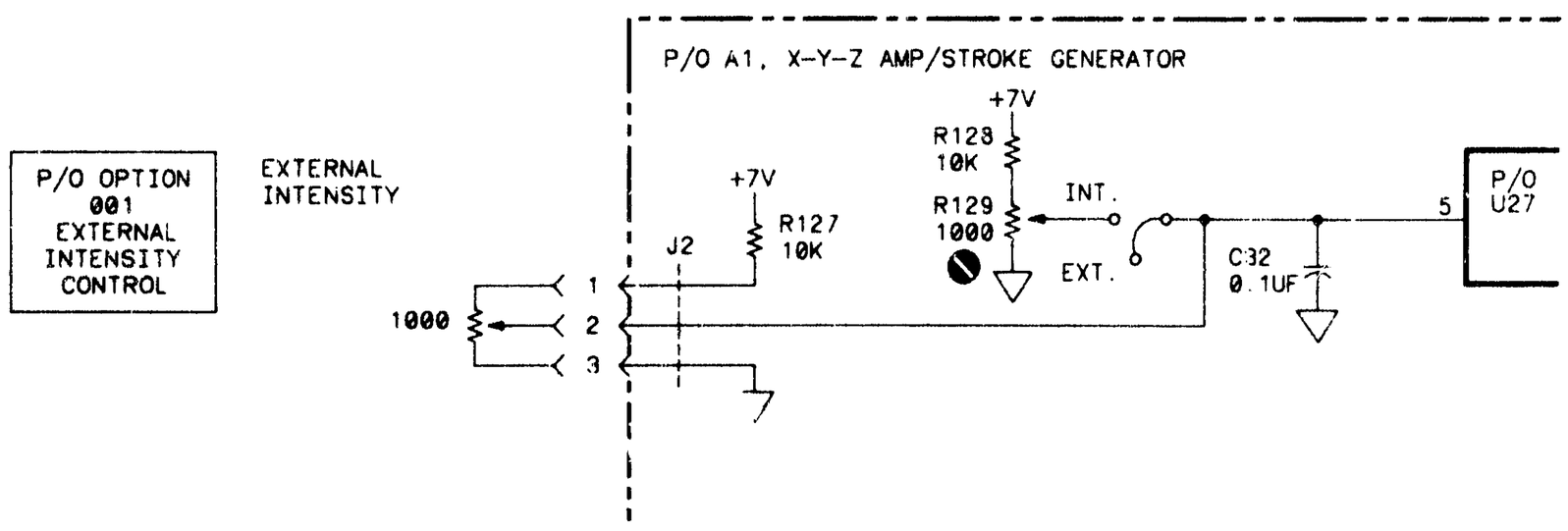


Figure 1-5. External Intensity Potentiometer Connection.

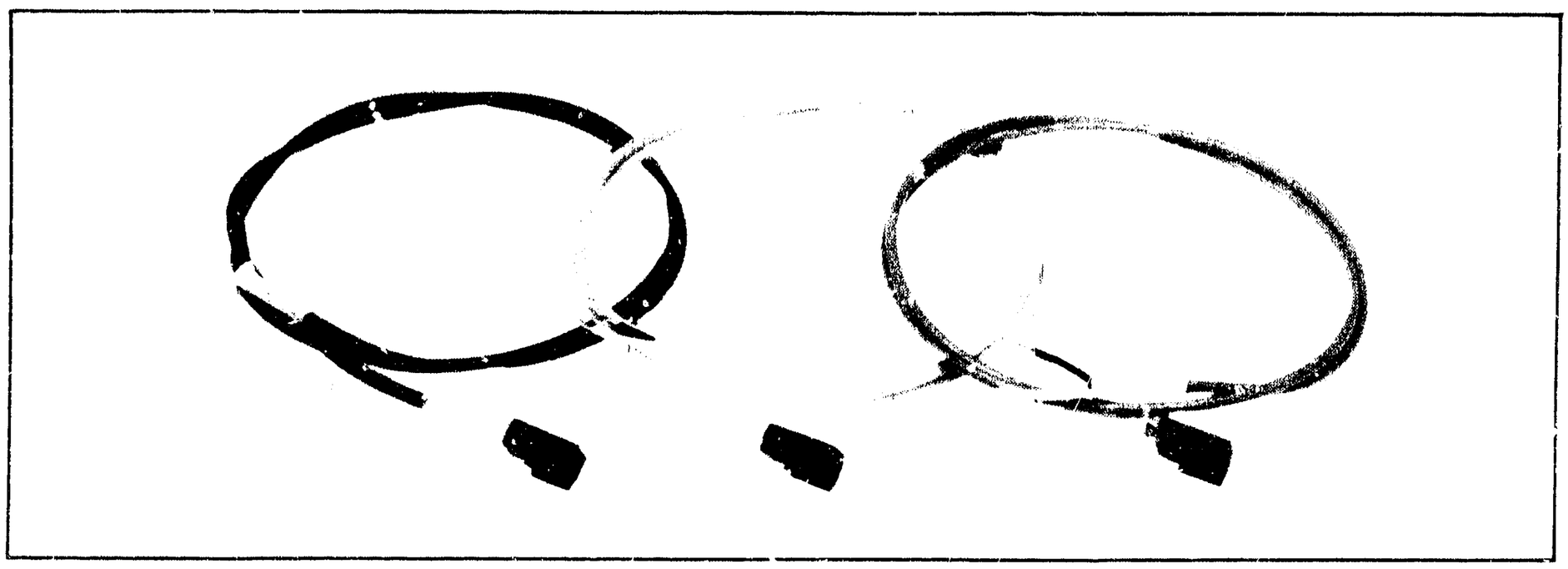


Figure 1-6. Option 323 Cable Detail

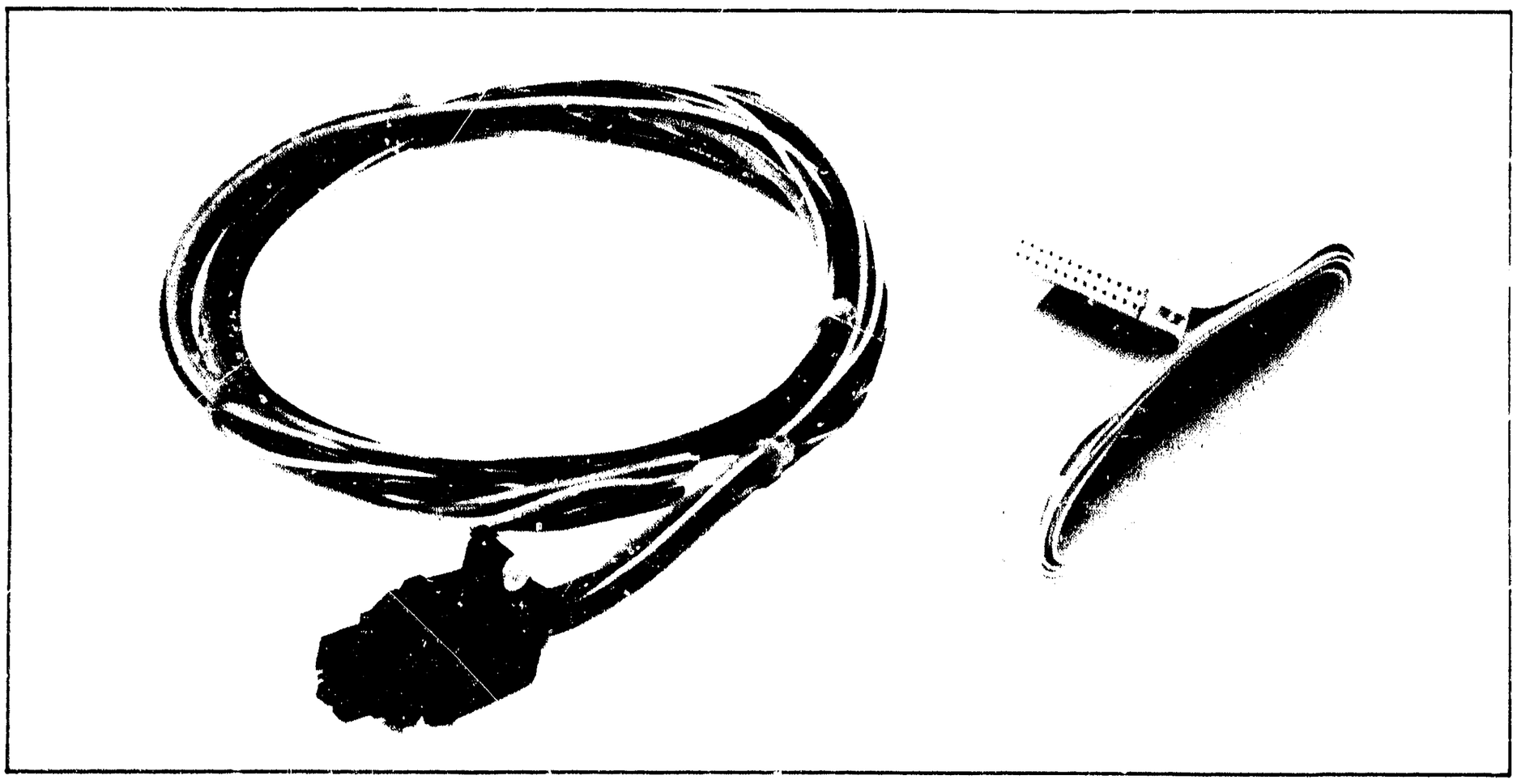


Figure 1-7. Cable Assembly Option 325

1-22. OPTION 323.

1-23. Option 323 provides output cables for the X-Y-Z outputs. The cables are 60.9 cm (24 in.) long and are ready to connect to the X-Y-Z outputs on the Stroke Generator Board (A1). The other end of the cables have stripped ends for connection to the user's circuit.

1-24. The X-Y-Z outputs can drive another peripheral such as a large screen display. In order to reproduce the high resolution display of the 1345A, the added peripheral should have a bandwidth of 5 MHz or greater. The open circuit amplitude of the X and Y axis output signals range from 0 to 1V from a source impedance of approximately 340 ohms. The Z axis open circuit amplitude is the same, however the source impedance is approximately 250 ohms. These output circuits are designed for use with Hewlett-Packard large screen displays with 10K ohm input impedances. These outputs cannot drive impedances less than 600 ohms. It is recommeded that shielded cable be used between the X-Y-Z outputs and the peripheral. The outer conductor of the cable should be grounded at each end. Connect the X-Y-Z outputs according to the following table.

X OUTPUT — A1J5

Y OUTPUT — A1J4

Z OUTPUT — A1J3

1-25. A two pin female metric post type connector (Molex 22-01-1023 or equivalent) is required to mate with the X-Y-Z output connectors. If the X-Y-Z output cables used are longer than 61 cm (24 in.) then driver amplifiers with the following characteristics must be designed:

BANDWIDTH: 50MHz (7 ns rise time with 1% pertubation).

SETTLING TIME: 100 ns

INPUT IMPEDANCE: 10K ohms.

OUTPUT IMPEDANCE: 50 ohms.

OUTPUT VOLTAGE: 0 Vdc to 1 Vdc into 50 ohms.

1-26. OPTION 325.

1-27. This option provides a DC power input cable and an I/O interface cable with connectors that interface with the 1345A. The cables are 91.4 cm (36 in.) long and have stripped ends on the other end for connection to the user's circuit. The I/O interface cable should be trimmed for the maximum recommended length of ≤ 60.9 cm (24 in.) prior to installation.

1-28. RECOMMENDED TEST EQUIPMENT.

1-29. Equipment required to test and maintain the 1345A is listed in table 1-5. Other equipment may be substituted if it meets or exceeds the critical specifications listed in the table.

Table 1-5. Recommended Test Equipment

INSTRUMENT TYPE	RECOMMENDED MODEL	REQUIRED CHARACTERISTICS	REQUIRED FOR:
MONITOR OSCILLOSCOPE	HP Model 1740A	Bandwidth: 100MHz Input Z: 50 ohms and 1M ohm shunted by approximately 20pf	Adjustment
DIGITAL VOLTMETER	HP Model 3466A	Voltage Rating: -15V to +250V Accuracy: 0.1% Input Resistance: 10M ohm	Adjustment
1000:1 DIVIDER PROBE	HP Model 34111A	Voltage Rating: 12KV	Adjustment
10:1 DIVIDER PROBE (Qty2)	HP Model 10041A (supplied with HP Model 1740A)	Input Resistance: 1M ohm shunted by approximately 12pf	Adjustment
POWER SUPPLY	CONVERTER CONCEPTS Model VST 25-37-01-1000	Output Voltage: +5V at 3.0A +15V at 1.2A -15V at 0.3A	Performance Checks and Adjustment

Note: CONVERTER CONCEPTS
435 Main Street
Pardeeville, WI 53954, USA

Outside U.S.A. contact Factory Product Support

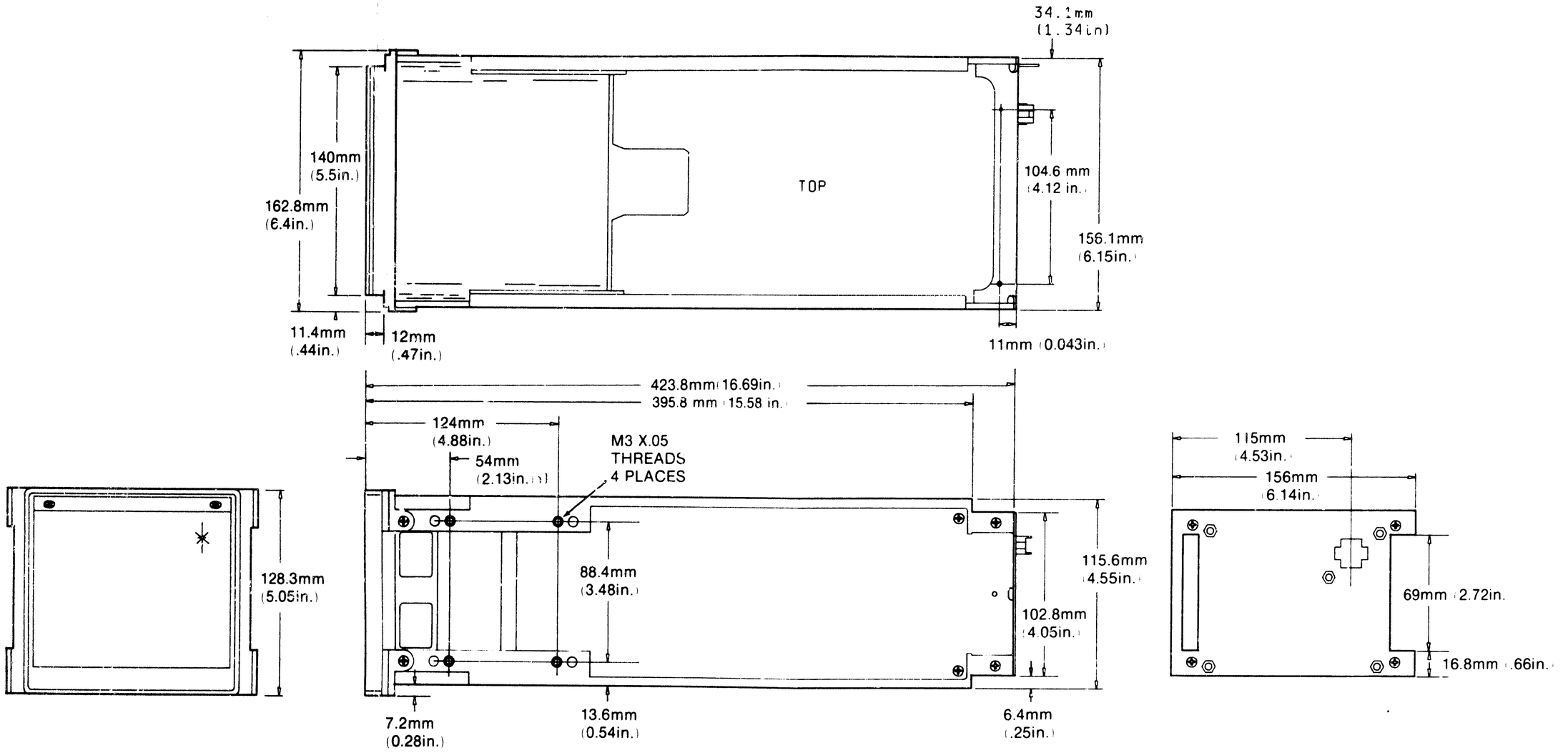


Figure 1-8.
Dimensional Detail, 1345A

SECTION II

INSTALLATION

2-1. INTRODUCTION.

2-2. This section provides installation instructions for the Model 1345A Digital Display. It also contains detailed mechanical information, location of center of gravity, suggested mounting configurations, and temperature considerations for the Model 1345A. This section also includes information about initial inspection and damage claims, preparation for use storage and shipment.

2-3. INITIAL INSPECTION.

2-4. Inspect the shipping container for damage. If the shipping container or cushioning material is damaged, it should be kept until the contents of the shipment have been checked for completeness and the instrument has been checked mechanically and electrically. The contents of the shipment should be as listed in the "Accessories Supplied" paragraph in section I. Procedures for checking electrical performance are given in Section IV. If the contents are incomplete, if there is mechanical damage or defect, or if the instrument does not pass the Performance Tests, notify the nearest Hewlett-Packard office. If the shipping container is damaged, or the cushioning material shows signs of stress, notify the carrier as well as the Hewlett-Packard office. Keep the shipping material for carrier's inspection. The HP office will arrange for repair or replacement at HP option without waiting for claim settlement.

2-5. PREPARATION FOR USE.

WARNING

Read the Safety Summary in the front of this manual and the "Safety Considerations" paragraph in Section I before installing or operating this instrument.

2-6. POWER REQUIREMENTS.

2-7. The 1345A requires the following power supplies for proper operation:

+15Vdc ±5% regulated, 1.05A, <10 mV p-p ripple
+5Vdc +5% –0% regulated, 0.75A, <50 mV p-p ripple
–15Vdc ±5% regulated, 0.3A, <10 mV p-p ripple

NOTE:
When the 1345A is equipped with Option 704 (Vector Memory), current requirements for the +5V supply are 1.8A.

2-8. POWER CONNECTOR.

2-9. A 6 Pin connector (Amp 1-350241-9 or equivalent) is required to mate with the rear panel power connector.

2-10. I/O CONNECTOR.

2-11. A 26 pin connector (ANSLEY 609-2630 or equivalent) is required to mate with the rear panel connector. The connector is wired according to figure 2-2. The MAXIMUM recommended length of this connector cable is ⩽ 60.9 cm (2 ft.) in length.

The data tranfer rate is controlled by the 1345A and the user processor. The length of each vector influences the rate. The 1345A requires approximately 1.5 to 100 microseconds to process and draw each vector.

2-12. ANALOG OUTPUTS (X,-Y,-Z).

2-13. The purpose of the Analog Output jacks on the X-Y-Z/STROKE GENERATOR (A1) board is to connect an external X-Y-Z Display. The output signals can drive 1 V p-p into a nominal 340 ohm X or Y load and a nominal 250 ohm Z load. The bandwidth of the external X-Y-Z display should be at least 3 MHz or greater for the

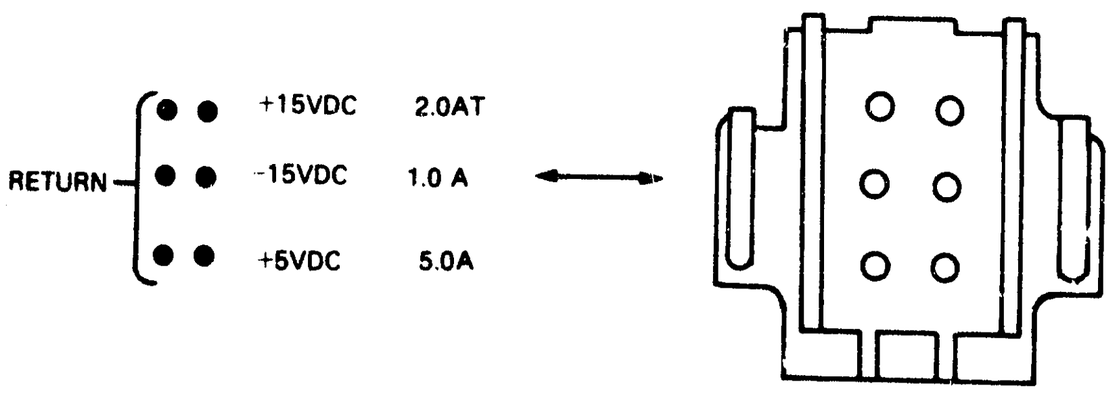


Figure 2-1. Power Connection for 1345A

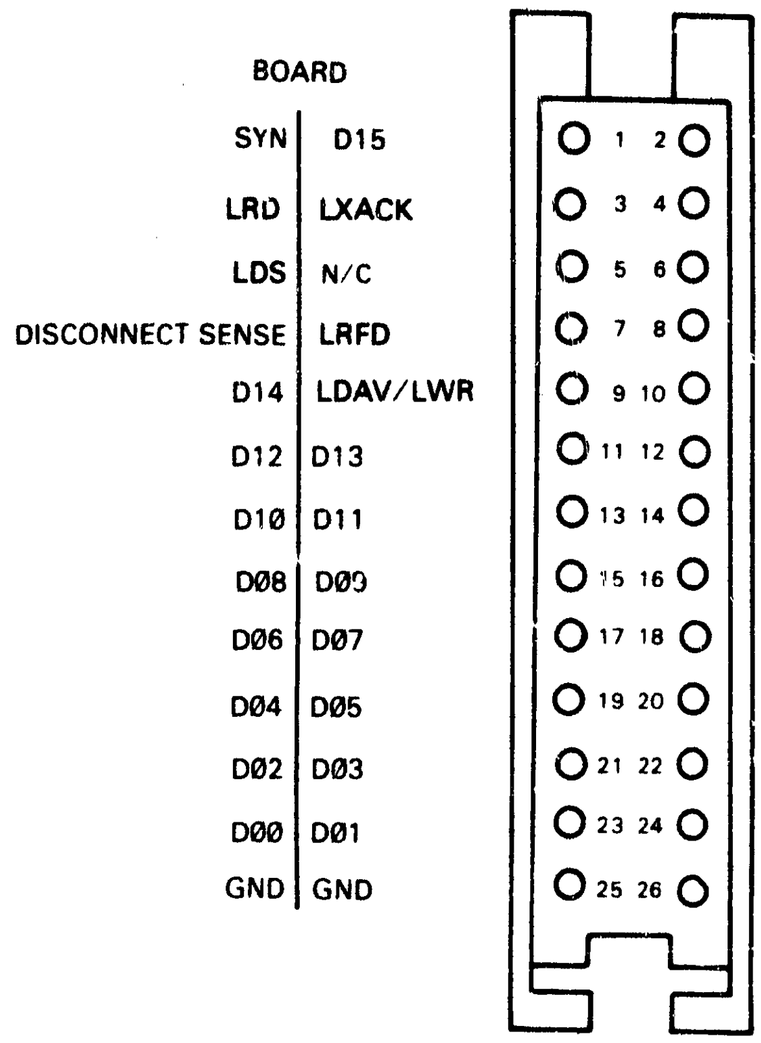


Figure 2-2. 1345A I/O Connector

X, Y Axis and 10 MHz or greater for the Z Axis. The interface cables should not exceed 1.83 m (6 ft.) in length. Use the following table for interfacing:

Ref Desig	Output
A1J3	Z AXIS OUTPUT
A1J4	Y AXIS OUTPUT
A1J5	X AXIS OUTPUT

2-14. OPERATING ENVIRONMENT.

2-15. Temperature. The instrument may be operated in temperatures from 0° C to +65° C.(+32° F to +149° F).

NOTE:
The +65° C (+149° F) temperature specification reflects the maximum allowable operating temperature with the 1345A enclosed, not the ambient temperature of the system housing. It is recommended that a minimum of 0.28m^3/min (10ft^3/min) of air flow is forced around the instrument to ensure that the maximum operating temperature of +65° C (+149° F) is not exeeded.

Figure 2-3 (Point A) shows the recommended point where the ambient temperature measurement should be made. The surface temperature at points "B" in figure 2-3 may typically be +50° C (+122° F) or more above the ambient temperature. It is recommended that heat-sensitive devices or circuits not be placed in close proximity to these points.

2-16. Humidity. The instrument may be operated in environments with humidity up to 95%. However, the instrument should also be protected from temperature extremes which cause condensation within the instrument.

2-17. Altitude. The instrument may be operated at altitudes up to 4600 m (15,000 ft.).

2-18. MECHANICAL CONSIDERATIONS.

2-19. Shock and Vibration. The Model 1345A is designed to meet HP Class B Shock and Vibration Standards. The instrument has been subjected to the shock and vibration levels as shown in tables 2-1 and 2-2. If the system is subjected to shock and vibration levels greater than those shown in tables 2-1 and 2-2 then the instrument must be mounted to attenuate the applied shock and vibrations. For other shock amplitude or duration, the product of amplitude and duration must not be greater than the integral of 30 G peak, 11 ms duration, 0.5 sinewave. The design of the

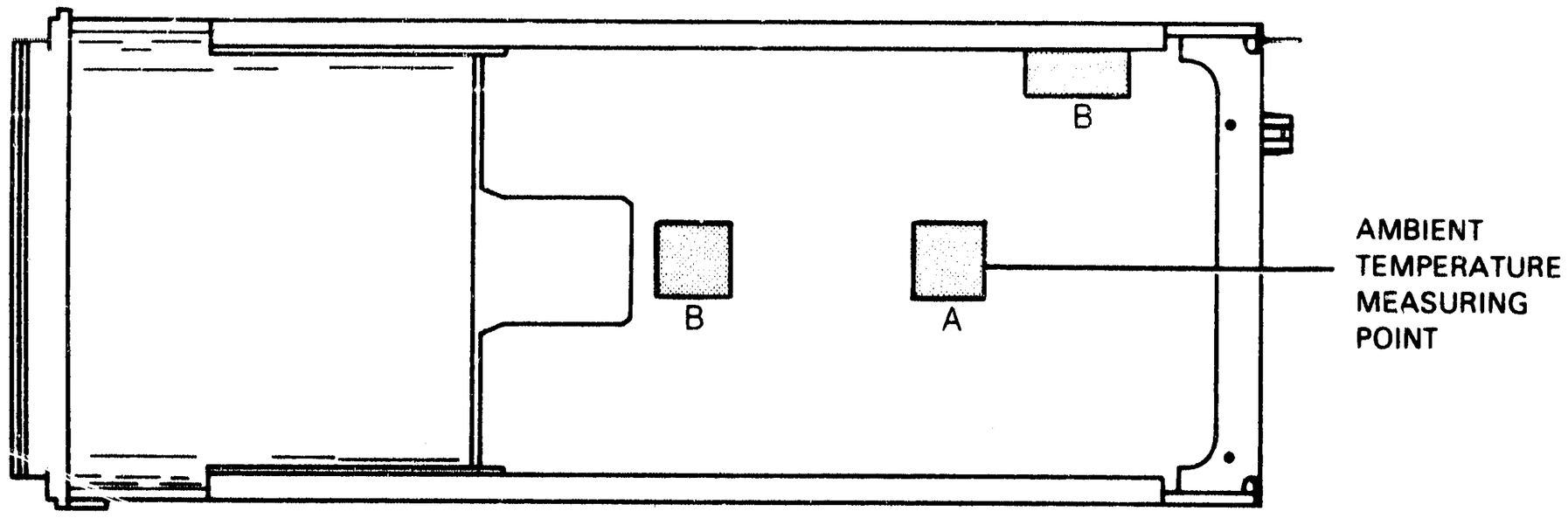


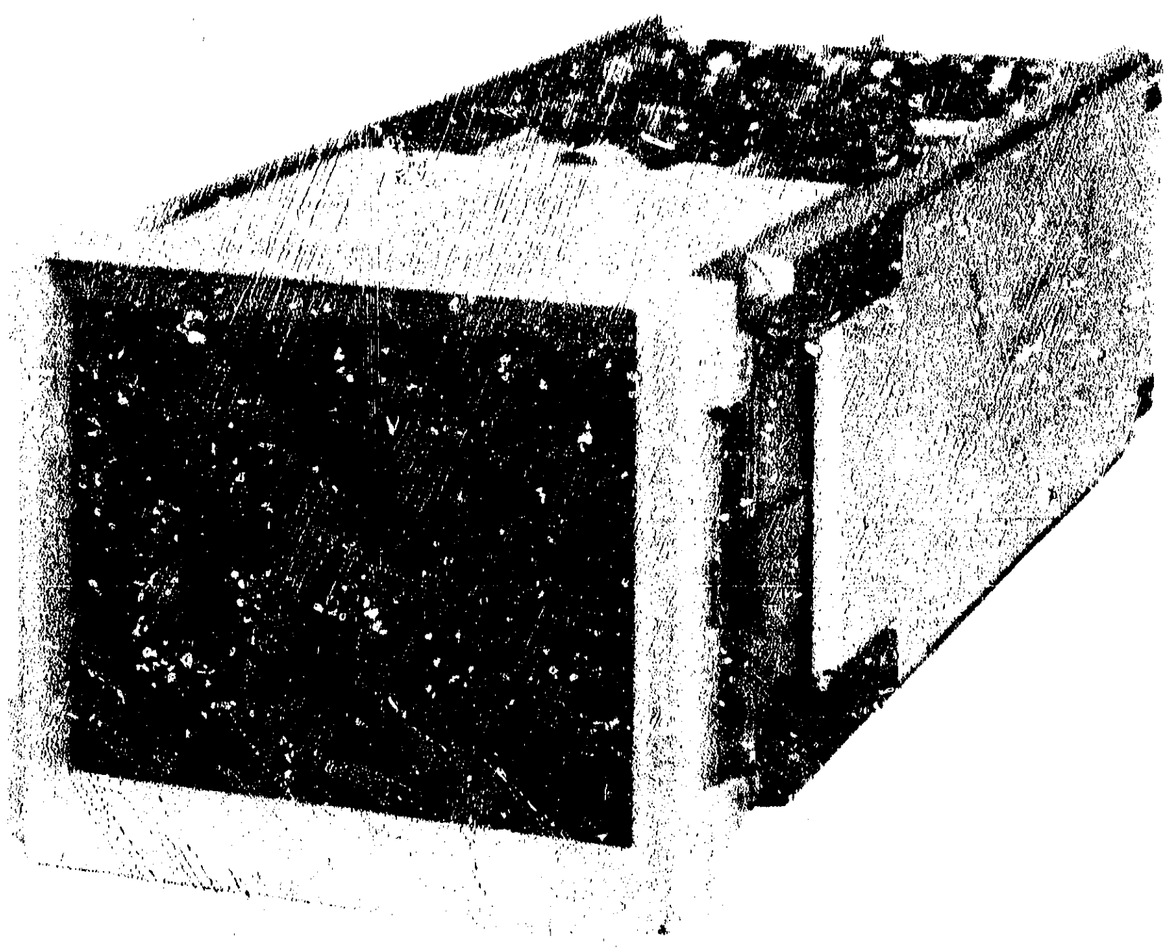
Figure 2-3. 1345A Ambient Temperature Measurement

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mounting must be checked by measuring the shock and vibration of the 1345A when mounted in the final configuration. The 1345A mass, center of gravity, and second moments of inertia information should only be used as a guideline for initial design of the system.

2-20. Moments of Inertia. The second moments of inertia I'x, I'y, I'z about the major axis, as defined in figure 2-4, through the center of gravity of the 1345A are listed below:

I'z: 150 cmgm sec^2 (0.13 in.lb sec^2)
I'x: 670 cmgm sec^2 (0.58 in.lb sec^2)
I'y: 716 cmgm sec^2 (0.62 in.lb sec^2)

2-21. MOUNTING CONFIGURATION.

2-22. The recommended mounting configuration for the 1345A is shown in figure 2-5. It is recommended that the instrument be supported at the front side casting and rear panel mounting holes.

2-23. STORAGE AND SHIPMENT.

2-24. Environment. The instrument may be stored or shipped in environments within the following limits:

Temperature:	–40° C to +75° C (–40° F to +167° F)
Humidity:	up to 95% relative Humidity at +40° C (+104° F).
Altitude:	15,300 m (50,000 ft.).

The instrument should also be protected from temperature extremes which cause condensation within the instrument.

2-25. PACKAGING.

2-26. Original Packaging. Containers and materials identical to those used in factory packaging are available through Hewlett-Packard offices. If the instrument is being returned to Hewlett-Packard for servicing, attach a tag indicating the type of service required, return address, model number, and full serial number. Also mark the container FRAGILE to ensure careful handling. In any correspondence, refer to the instrument by model number and full serial number.

2-27. Other Packaging. The following general instructions should be used for re-packing with commercially available materials.

a. Wrap instrument in heavy paper or plastic. (If shipping to Hewlett-Packard office or service center, attach a tag indicating type of service required, return address, model number, and full serial number).

b. Use a strong shipping container. A double-wall carton made of 350-pound test material is adequate.

c. Use a layer of shock-absorbing material 70 to 100 mm (3 to 4 inch) thick around all sides of the instrument to provide firm cushioning and prevent movement inside the container. Protect control panel with cardboard.

d. Seal shipping container securely.

e. Mark shipping container FRAGILE to ensure careful handling.

f. In any correspondence, refer to instrument by model number and full serial number.

Table 2-1. Minimum Shock Level Withstand Capability

Class	Product Weight (kg)	Shock Intensity (g)	Shock Pulse Duration (milliseconds)
B	4.4	30	11

Table 2-2. Vibration Specifications

Class	Frequency Hertz	Period Minutes	Amplitude Peak-Peak	Dwell Minutes	Amplitude Peak-Peak
B	5-55-5	15	0.38 mm (.015in.)	10	Note 1

Note 1: 3.17 mm (0.125 in.) 5-10 Hz
1.52 mm (0.060 in.) 10-25 Hz
0.38 mm (0.015 in.) 25-55 Hz

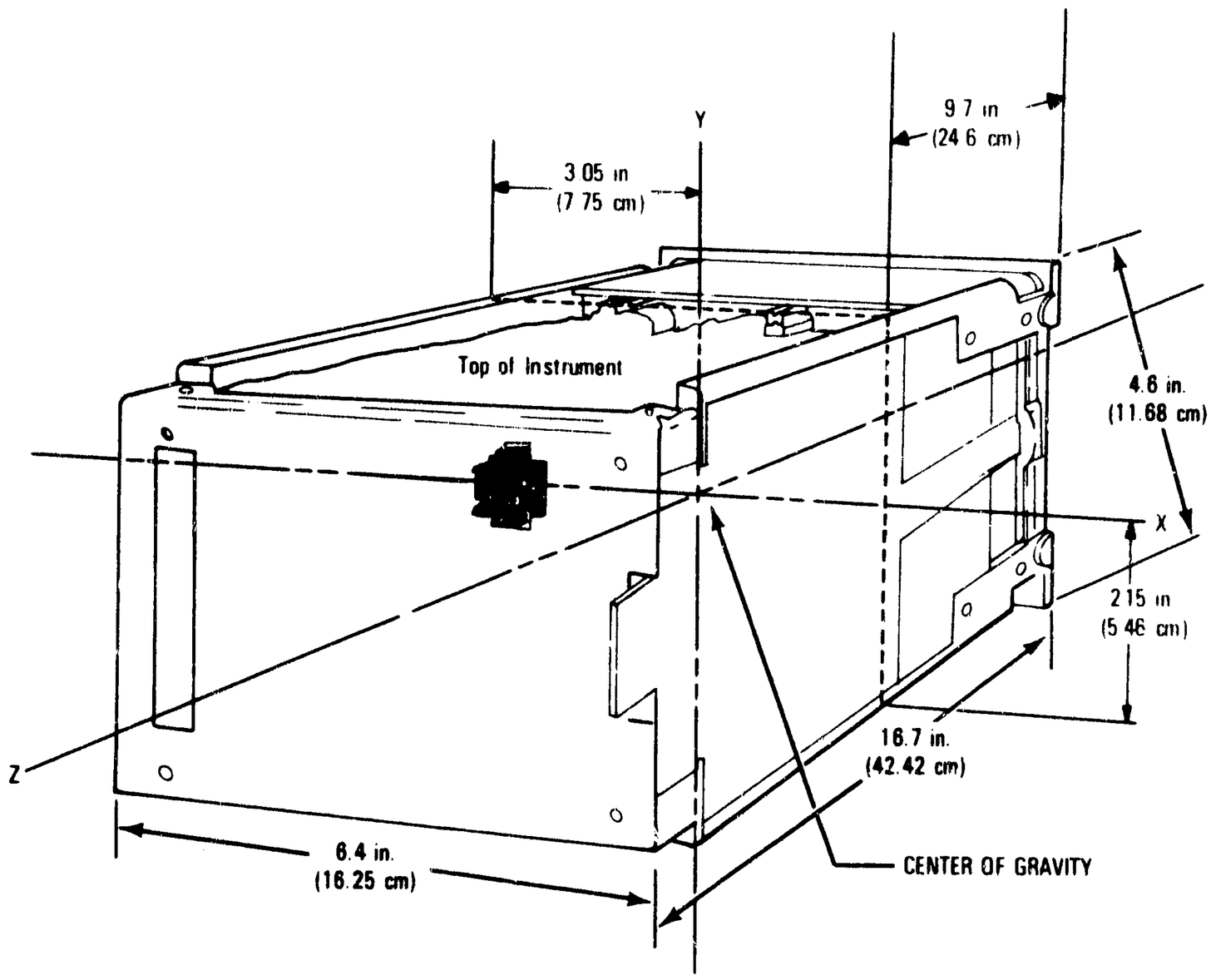


Figure 2-4. Definition of Moments of Inertia and Center of Gravity

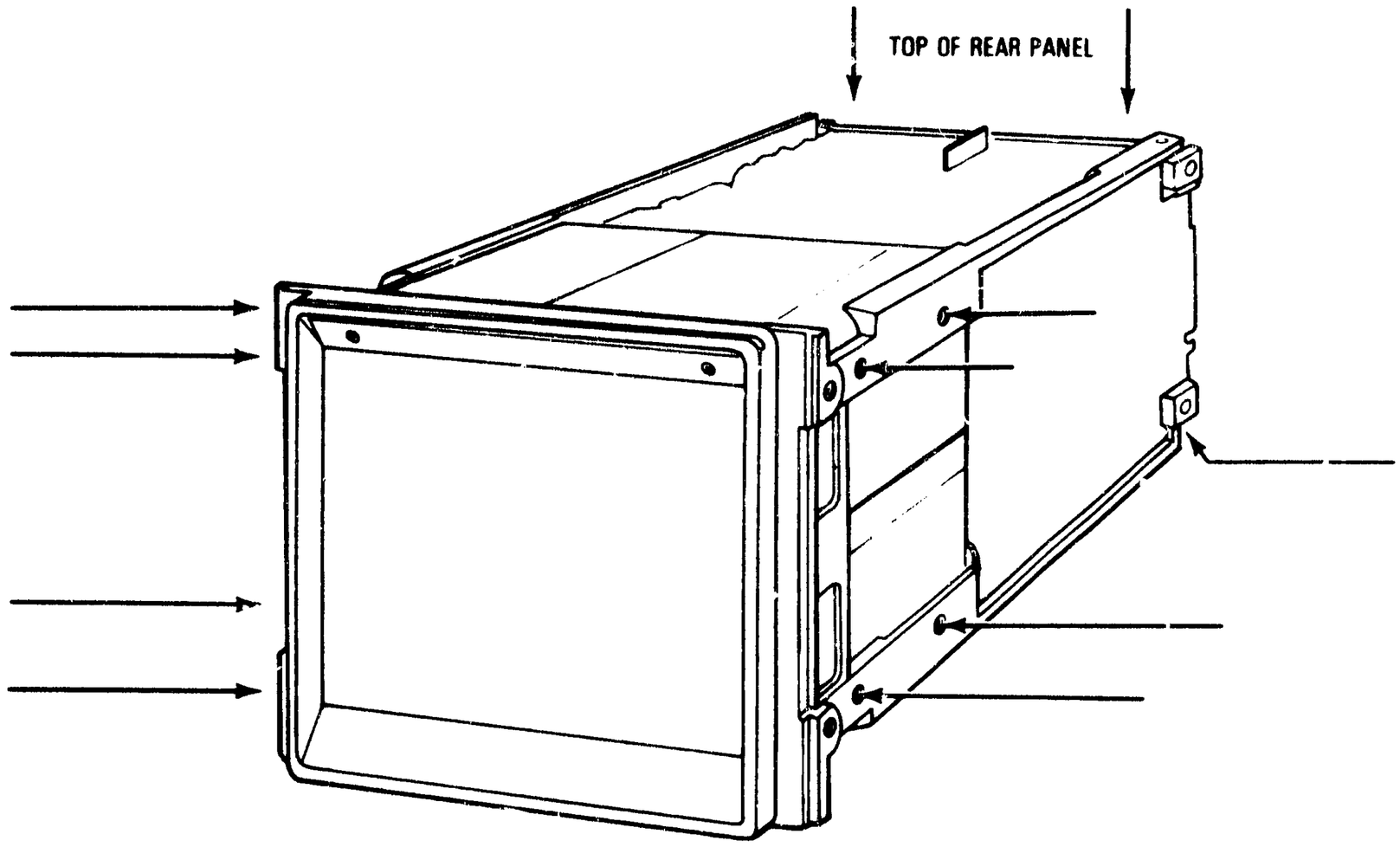


Figure 2-5. Recommended Mounting Configuration

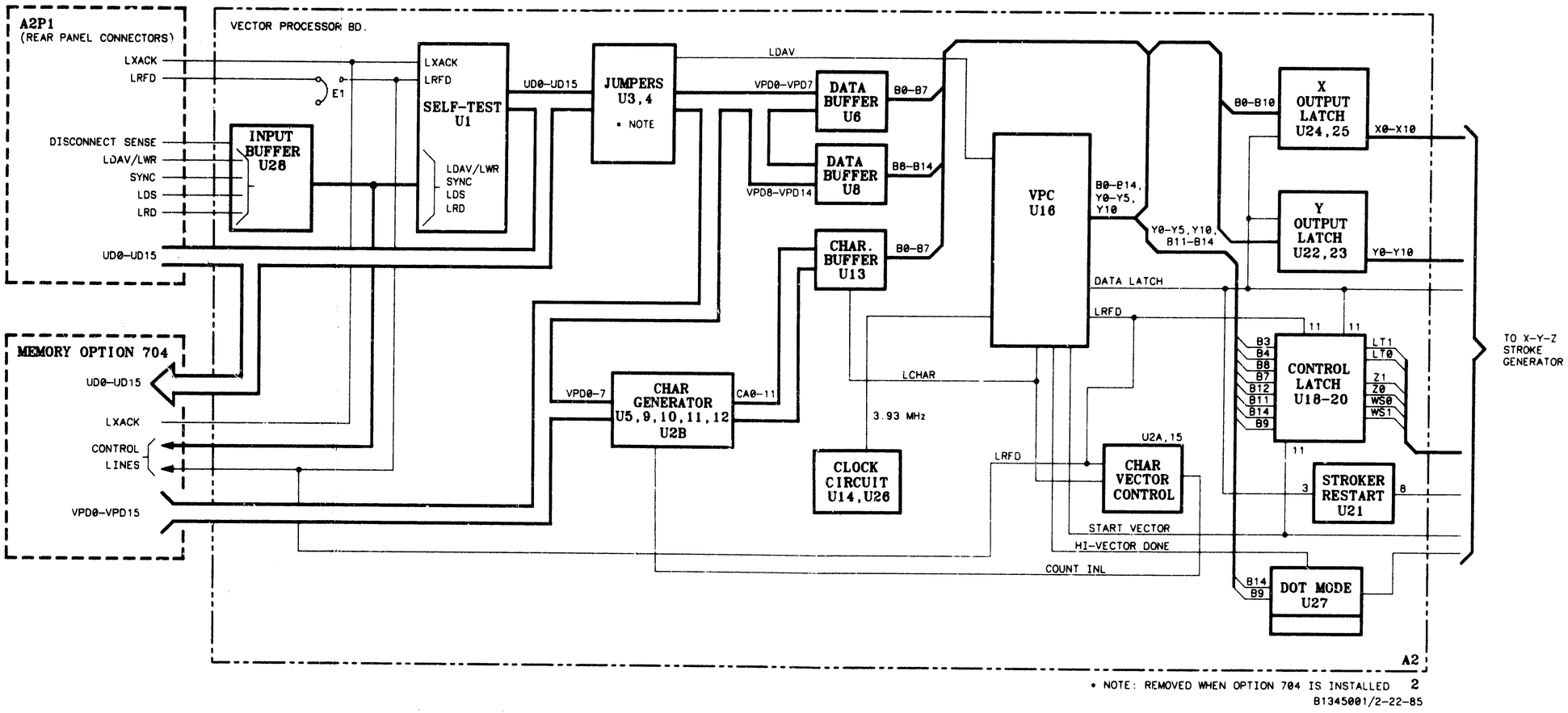


Figure 3-1.
Major Signal Line Definitions

SECTION III

OPERATION

3-1. INTRODUCTION.

3-2. The purpose of tnis section is to give detailed information concerning the operation, I/O interfacing, and programming of the 1345A. It includes a list of the programming instructions and a section containing a brief explanation of "bit programming". There are also several programming examples throughout this section.

3-3. OPERATING CONSIDERATIONS.

Refer to figure 3-1 for the following discussion.

3-4. SIGNAL LINE DEFINITIONS.

D0-D15 D0 through D14 are the vector data lines. (TTL positive logic).
D15 is used only with Option 704 (Vector Memory option).

LDAV Data valid signal line: (Active low) Signal from user to 1345A. New output data is available on data bus.

LRFD Ready for data signal line: (Active low) Signal from 1345A to user.
1345A is ready for next data transfer.

DISCONNECT SENSE:
This line is active low and is used to determine if the 1345A is connected to a controller. The user interface MUST keep this line low when the 1345A is in use. The internal Performance Verification pattern will be displayed if this line is not grounded (held low). Undefined conditions will result if the other signal lines are not either disconnected or tri-stated when "Disconnect Sense" is disconnected, pulled high, or tri-stated.

3-5. SIGNAL LINE DEFINITION FOR OPTION 704.

LSYNC External display refresh synchronization signal line: A positive-going (TTL) edge on this line starts a display refresh cycle when external sync mode has been selected via a jumper wire on the Vector Memory board (option 704).

LXACK Acknowledge signal line: When low, this line indicates to the user processor that the Vector Memory has acknowledged the Read or Write operation command from the processor.

LDS Device Select signal line: When low this line enables the Vector Memory for communication from or to the user processor (write/read).

LWR Memory Write signal line: when low this line indicates that the 16-bit Data Bus contents are to be written into either the current Vector Memory location (specified by Vector Memory address pointer) or into the Vector Memory address pointer register.

LRD Memory Read signal line: when low this line indicates that the contents of the current Vector Memory location (as specified by the Vector Memory address pointer) are to be placed on the 16-bit Data Bus for transmission back to the user processor.

NOTE

Whenever a Vector Memory location has been either written into or read from by the user processor, the Vector Memory address pointer auto-increments to the next Vector Memory location (address).

3-6. FUNCTIONAL BLOCKS OF THE 1345A (Figure 3-2).

The following descriptions highlight the main functional blocks of the 1345A.

POWER SUPPLY. The power supply generates the required voltages to drive the CRT.

VECTOR PROCESSOR. The vector processor converts the 16-bit input vector data into defined vectors. The vector processor receives 16-bit data using a two wire handshake which is controlled by the vector processor and the 1345A. The 16-bit input data is decoded into one of four commands that plot either vectors or text using an internal character generator.

STROKE GENERATOR. The stroke generator converts the digital vector data from the vector processor into vectors displayed on the CRT. The stroke generator can be programmed to give several combinations of line types, intensities, and writing speeds.

X-Y-Z AMPLIFIERS. The vectors created in the stroke generator are amplified to levels needed to drive the CRT. The X and Y signals are inputs to positional and focus correction circuitry. The Z signal is input to beam drive and correction circuitry. The two correction circuits insure a focused circular dot in all areas of the CRT at all intensities.

VECTOR MEMORY (Option 704). The 1345A may be ordered with an optional 4K by 16-bit memory for graphics information storage. This allows the user to write the vector data to the vector memory only once. The vector memory will then handle the refresh requirements of the display. This memory can store and refresh up to 4096 commands. The vector memory has an internal refresh timer that generates a refresh cycle approximately once every 16.6 ms.

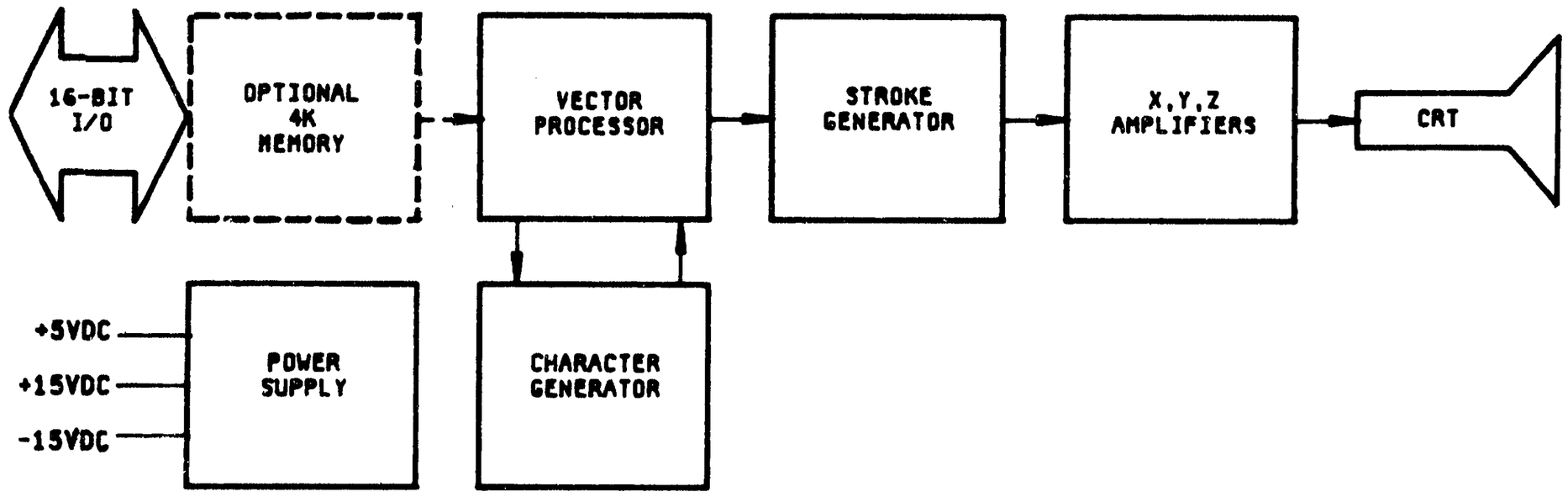


Figure 3-2. 1345A Functional Block Diagram

3-7. USER INSTRUMENT REQUIREMENTS.

The 1345A is designed as an internal display component for instrumentation. The user instrument must provide the required DC voltages +5Vdc, +15Vdc, and -15Vdc. These are supplied through the rear panel power connector shown in Section II, figure 2-1.

The host instrument must acquire and format the data to be displayed by the 1345A CRT. The 1345A will accept only four data formats, which define the four graphic commands. These are PLOT, GRAPH, SET CONDITION, and TEXT. The formats for these commands are described later in this section. The 1345A accepts commands via a 16-bit data bus from the user instrument. Figure 2-2 in Section II shows the I/O connector.

The example system in figure 3-3 has three separate function blocks. The host processor is a microprocessor that is programmed to control measurement and data handling tasks of the instrument. Data acquisition is handled by the instrument's acquisition circuitry. The purpose of the interface is to handle data transfers to the 1345A. If the optional vector memory is installed, the 1345A 16-bit data bus is bidirectional and the interface may need to handle bidirectional data transfers.

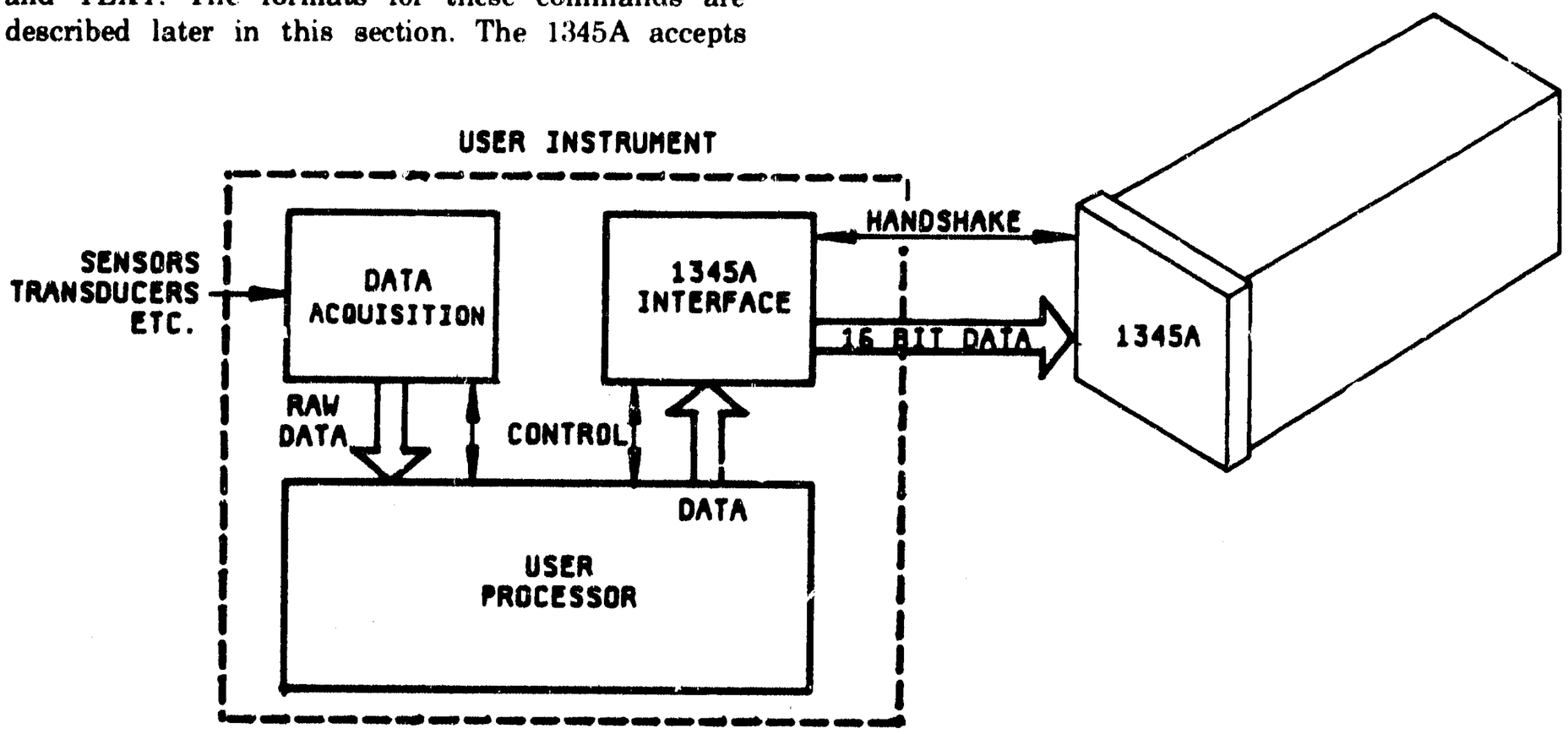
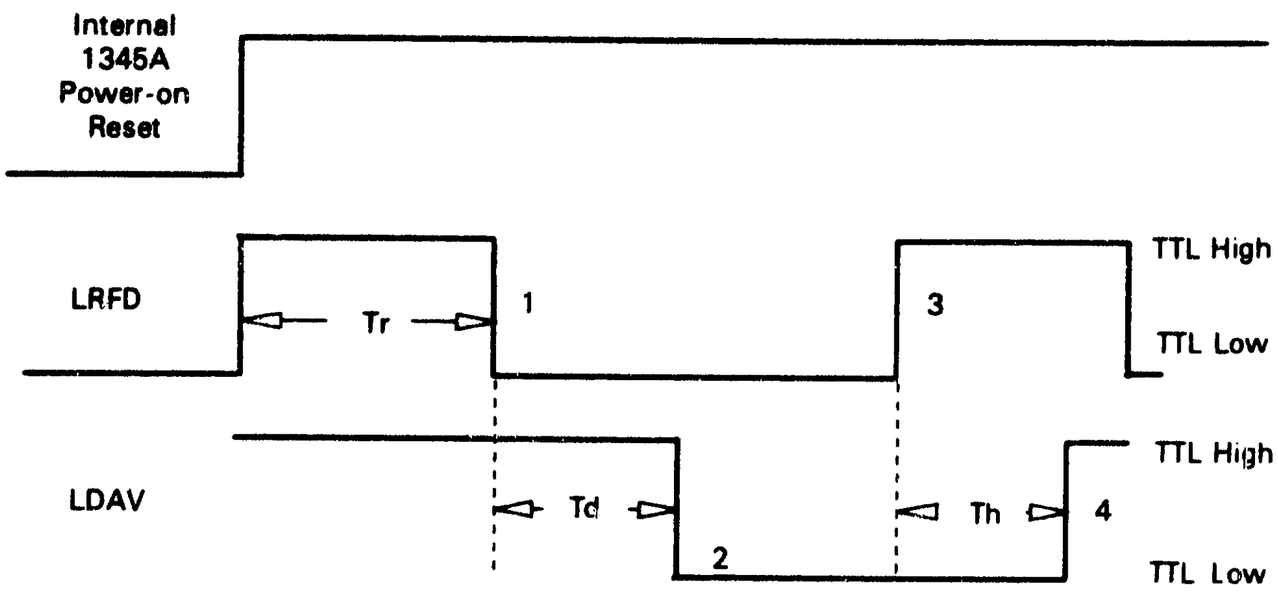


Figure 3-3. Block Diagram of an Example System Incorporating the 1345A

3-8. HANDSHAKE TIMING



Tr — Ready Time (1345A Power-on delay) 400 nsec min
100 μsec max
(assume LDAV is high at Power-on)

Td — Data Valid Delay Time (after LRFD goes low) 0 nsec min

Th — Data Valid Hold Time (after LRFD goes high) 0 nsec min

Figure 3-4.
LRFD and LDAV (Ready for Data, Data Valid) Handshake

TRANSFER SEQUENCE:

1. 1345A sets LRFD low to indicate that it is ready for a word from the 16-bit Data Bus.

2. User processor sets LDAV low to indicate that the contents of the 16-bit Data Bus are valid.

3. 1345A returns LRFD high to indicate that it has accepted the word from the 16-Bit Data Bus.

4. User processor returns LDAV high so that the 1345A can initiate the next transfer.

5. 1345A sets LRFD low to indicate that it is ready for a word from the 16-bit Data Bus.

RESTRICTIONS:

a. User processor can set LDAV low at the same time or after 1345A sets LRFD low, but NOT BEFORE.

b. User processor can return LDAV high at the same time or after 1345A returns LRFD high, but NOT BEFORE.

c. 1345A will not set LRFD low unless LDAV is high.

NOTE

While LDAV remains low, the 1345A will not act on the command from the Data Bus, even though it has signalled that it has accepted the word from the Data Bus. It is recommended that the host system keep Th to a minimum.

d. Data on the 16-bit Data Bus must remain valid as long as LDAV is low.

NOTE

For maximum speed and performance, it is advisable that the host system use EDGE TRIGGERED logic.

Crosstalk. An important consideration in digital signal transmission is crosstalk between signal lines. Proper use of the 1345A two wire handshake, LRFD and LDAV, will minimize the possibility of crosstalk during data transmission. Another consideration is that of signal line length. It is recommended that the I/O cable be kept as short as possible with a maximum cable length of ≤60.9cm (2 ft.). By using the correct handshake sequence and keeping signal lines as short as possible, the potential of crosstalk can be kept to a minimum.

3-9. INSTRUCTIONS

The 1345A creates pictures by a technique called random vector plotting. A line is defined by its endpoints in 2048 by 2048 cartesian coordinate system. The origin (0,0) is in the lower lefthand corner. All points are positive reference. The 1345A references each vector by starting point, ending point,intensity level,line type, and writing speed.

The 1345A recognizes bits D0-D14 on its input Data Bus as being one of four commands. These four commands provide complete programmable vector and text generation with a minimum of command overhead. Most vector and text operations can be handled with only one 16-bit command word. The 1345A has the following Programming Command set.

MSB B15	B14	B13	B12	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1	LSB B0
COMMAND	COMMAND MODIFIERS														

Command	bit 14	bit 13
1. Set Condition	1	1
2. Plot	0	0
3. Graph	0	1
4. Text	1	0

The 1345A receives 16-bit data words over the 26 pin interface connector. These 16-bit data words are decoded by the 1345A into one of four distinct commands. Each 16-bit data word sent to the 1345A can be separated into two distinct data fields.

Each of the commands that the 1345A can recognize is selected by the state of data bits D14 and D13. Data bit D15 is used only for memory board operations and is discussed later. The 1345A without memory uses only data bits D0-D14 to determine the command. Data bit D15 is always 0. The lower 13 data bits D0-D12 are used as command modifiers. These modifiers allow each command to have several selectable attributes. Vecto. drawing operations are directly dependent on the status of these data bits in every 1345A command. Each of these commands and their modifiers will be discussed using programming examples. The 16-bit data for the examples will be in HEXADECIMAL or HEX format. The HEX format is easier to follow than 16-bit binary data words. Each HEX data word sent to the 1345A will be equivalent to a 16-bit binary word.

HEX Format Generation. Each 16-bit data word can be separated into four, four bit binary numbers. This allows each four bit binary number to have sixteen distinct combinations. Each of these combinations is assigned a HEX equivalence. The conversion from binary to HEX is contained in figure 3-5. Each data word in the following command examples will use this HEX format. These HEX representations will correspond to the required bit patterns recognized by the 1345A.

Hexadecimal Code	Binary Code b4	b3	b2	b1
0	0	0	0	0
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	1
8	1	0	0	0
9	1	0	0	1
A	1	0	1	0
B	1	0	1	1
C	1	1	0	0
D	1	1	0	1
E	1	1	1	0
F	1	1	1	1
Hex Code	C	F	0	8
Binary Code	1100	1111	0000	1000

Figure 3-5. Binary to HEX Conversion

1. Set Condition Command (B14 = 1, B13 = 1).

With bit 15 set to zero and command bits 14 and 13 set to one, the 1345A is commanded to draw all following vectors according to the configuration commanded until changed by subsequent condition command.

NOTE

A one (1) = TTL high; a zero (0) = TTL low.

The Set Condition command controls the intensity level, the line type, and the writing speed of vectors drawn on the CRT.

B15	B14	B13	B12	B11	B10	B9	B8	B7	B6*	B5	B4	B3	B2	B1	B0
0	1	1	I1	I0	X	L2	L1	L0	0	X	W1	W0	X	X	X

*B6 MUST be zero.

X = DON'T CARE

B14 = 1, B13 = 1: Set display configuration according to choices specified for intensity, line type, and writing speed.

I1	I0	(Intensity)
0	0	Blank
0	1	Dim
1	0	Half Brightness
1	1	Full Brightness

L2	L1	L0	(Line Type)
0	0	0	Solid Line
0	0	1	Intensify Endpoints (solid line)
0	1	0	Long Dashes
0	1	1	Short Dashes
1	0	1	Dots on Endpoints

Note: These are the only defined states for Line Type. Any other combination may result in lock-up of Vector Processor.

W1	W0	(Writing Speed)
1	1	0.05 in. per microsecond
1	0	0.10 in. per microsecond
0	1	0.15 in. per microsecond
0	0	0.20 in. per microsecond

When the line type "solid line with intensified endpoints" is selected, the intensity of the endpoints may vary due to optical illusion. As lines are linked together, the intensity of the point where one line ends and the next line starts is a function of the angle separating the lines. The closer the angle is to 180 degrees, the brighter the point. The closer the angle is to zero degrees (absolute), the dimmer the point.

By combining line intensity and writing speed parameters, up to twelve levels of discernible intensities can be generated. Figure 3-6 contains several example combinations. This allows the user to create displays with background graticules and intensify important trace data. The beam will be brightest with the intensity set at full bright at the slowest writing speed. The beam will be dimmest with the intensity set at dim at the fastest writing speed. The Set Condition command may be executed at any time and the vector attributes will remain in effect until another Set Condition command is executed.

6998h	Dim, Short Dash, Speed 0.05
7800h	Bright, Solid, Speed 0.2
7000h	Half Bright, Solid, Speed 0.2
7100h	Half Bright, Long Dash, Speed 0.2

Figure 3-6. Set Condition Examples in Hex

2. Plot Command (B14=0, B13=0)

With bit 15 set to zero and command bits 14 and 13 set to zero, the 1345A is commanded to move the display beam to a specific X-Y location each time that a Y coordinate is received.

The beam position may be moved with the beam either turned off or on.

The Plot command will draw all vectors according to the display configuration established by the last Set Condition command received by the 1345A.

Each time that a Y coordinate is received the beam status (on or off) for the beam movement is established. Also, the X-Y location to be moved to is formed from the last X coordinate received and the current Y coordinate. For example, to draw a vertical line send the 1345A: (1) Plot command-X value; (2) Plot command-Y1 value (with beam off); (3) Plot command-Y2 value(with beam on).

B15	B14	B13	B12	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0
0	0	0	XY	PC	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
					DATA										
					MSB										LSB

B14=0, B13=0:Plot Command.

XY
0=X coordinate (0-2047) as specified by D0-D10.
1=Y coordinate (0-2047) as specified by D0-D10.

PC (Beam Control Bit)
0=Move (beam off)
1=Draw (beam on)

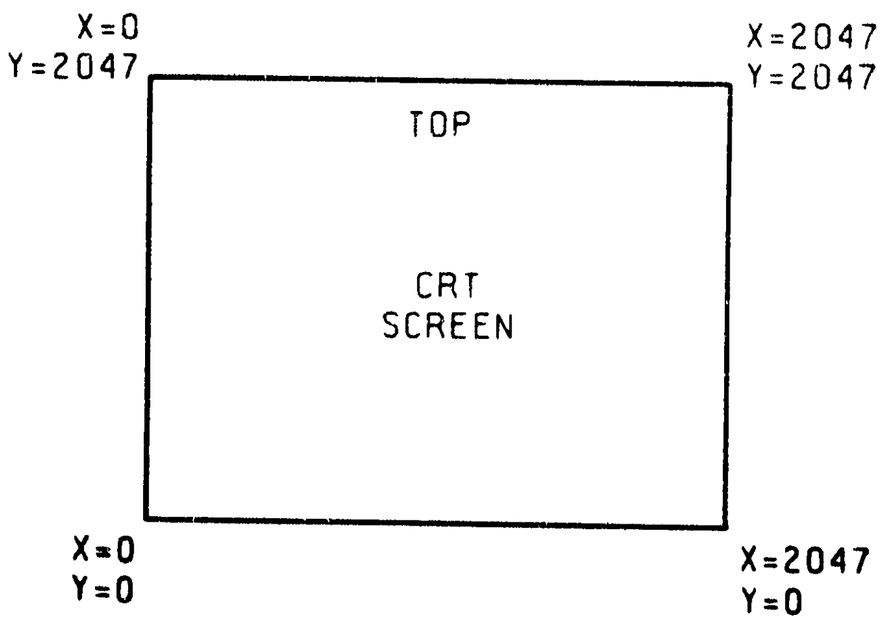


Figure 3-7. Vector Drawing Area

OPERATING AND SERVICE MANUAL

MODEL 1345A
DIGITAL DISPLAY

(Including Options 001, 323, 325, 504, 704, and 910.)

SERIAL NUMBERS

This manual applies directly to instruments with serial numbers prefixed **2515A.**

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Manual Part Number 01345-90916
Microfiche Part Number 01345-90816

PRINTED: MARCH 1985

Example 1.
An explanation of vector drawing will help clarify the process. In figure 3-8, there are three vectors defined by four endpoints. Each vector requires two endpoints. The vector from point 1 to point 2 requires two endpoint declarations. The vector from point 2 to point 3 requires only point 3 be declared as an endpoint, because point 2 is already established. The vector drawn from point 2 to point 3 is a vector with the beam off. This allows the beam to be moved to new vector starting points without affecting existing displayed vectors. The vector from point 3 to point 4 is drawn with the beam on. The correct sequence for constructing vectors in PLOT is ALWAYS X first, Y next, X,Y,X,...,Y, until the vector sequence is complete. A vector is plotted according to the last Set Condition command sent to the 1345A.

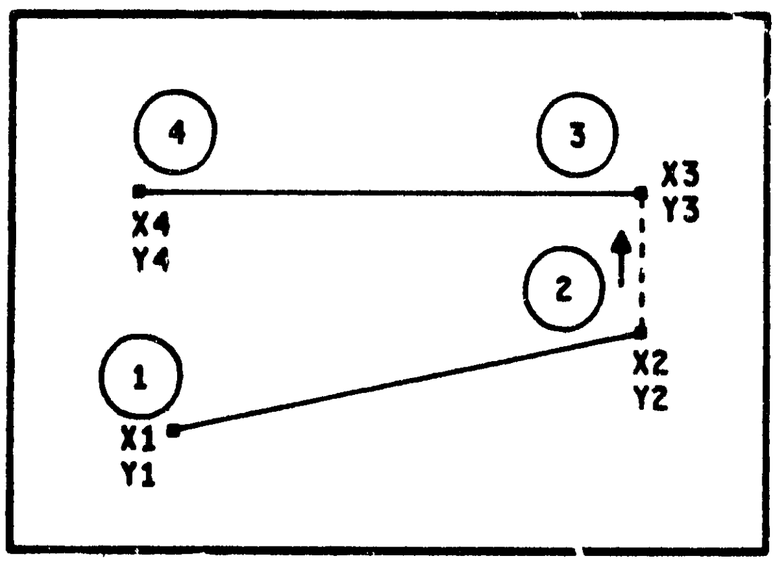


Figure 3-8. Vector Plotting

The "BEAM ON" bit in the PLOT command is ignored if the coordinate being specified is an X value. The beam status only has effect if the Y coordinate is being entered. The CRT beam will move to the location specified by the last X and Y coordinate values specified in the PLOT commands.

Example 2.
To draw a single vector defined by its endpoints in the vector drawing area, the 1345A would need to receive two sets of X and Y coordinates. The 1345A receives the coordinates in the specified order X1,Y1,X2,Y2. The beam is moved only when the Y coordinate is received. The status of the beam is only affected by the beam status bit in the Y coordinate command.

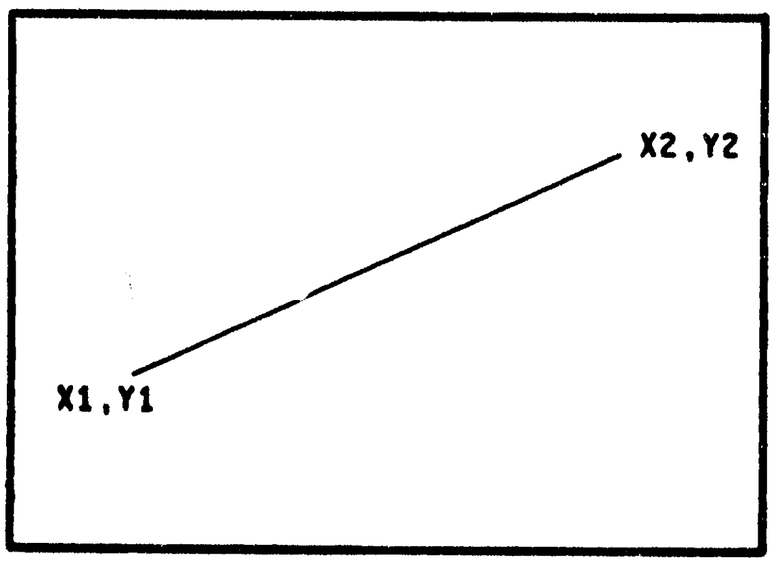


Figure 3-9. Vector Defined by Endpoints

Example 3.
To draw a square on the display, use the following procedure.

a. Send the 1345A a Set Condition command to configure display brightness, line type, and writing rate.

b. Send the 1345A a Plot X1 command.

c. Send the 1345A a Plot Y1 command with the beam off. This moves the beam to the starting point of the square.

d. Send the 1345A a Plot Y2 command with the beam on. This moves the beam to the X1,Y2 point shown in figure 3-10 (draws vector "1").

e. Send the 1345A a Plot X2 command, then a Plot Y2 (beam on) command. This moves the beam to X2,Y2 (draws vector "2").

f. Send the 1345A a Plot Y1 command with the beam on. This moves the beam to X2,Y1 (draws vector "3").

g. Send the 1345A a Plot X1 command, then a Plot Y1 (beam on) command. This moves the beam back to the starting point (draws vector "4").

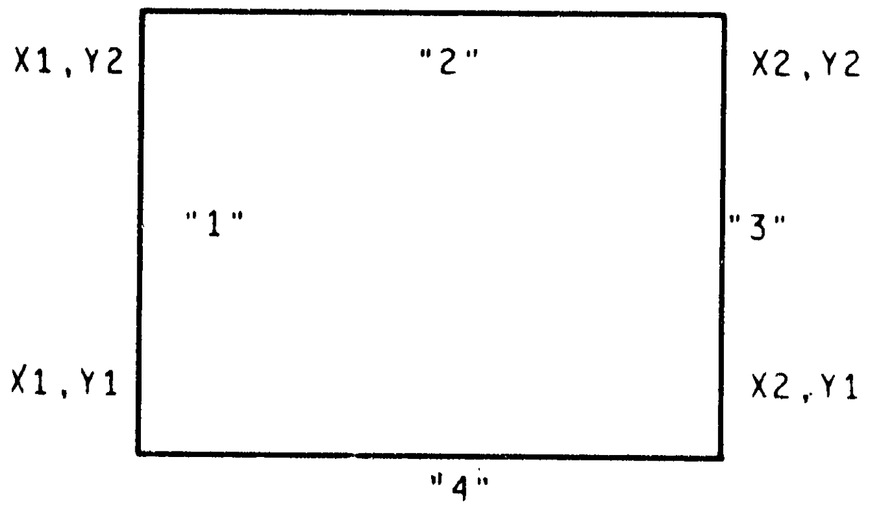


Figure 3-10. Drawing a Square on the Display

Example 4.
To draw two horizontal lines on the display, modify steps "d" and "f" in example 3 so that the 1345A receives the Plot Y command with beam off instead of beam on.

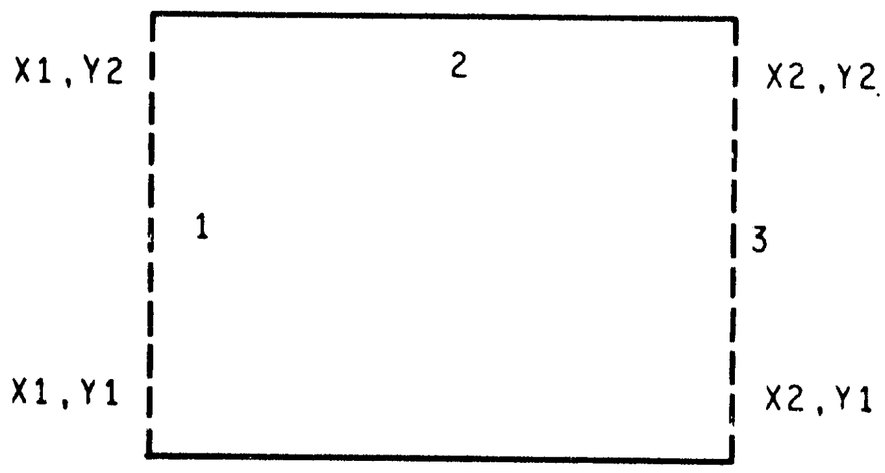


Figure 3-11. Two Horizontal Lines on the Display

The 16-bit HEX data equivalence code to draw figures 3-10 and 3-11 is shown below:

Command Step	Figure 3-10 data	Figure 3-11 data	1345A
1. Set Condition	7818h	7818h	Sets Vector type (Solid Full Bright,.05)
2. Plot X1	0200h	0200h	X1=512
3. Plot Y1(beam off)	1200h	1200h	move to Y1=512
4. Plot Y2(beam on)	1F00h	(beam off)1700h	move to Y2=1792
5. Plot X2	0F00h	0F00h	X2=1792
6. Plot Y2(beam on)	1F00h	1F00h	move to Y2=1792
7. Plot Y1(beam on)	1A00h	(beam off)1200h	move to Y1=512
8. Plot X1	0200h	0200h	X1=512
9. Plot Y1(beam on)	1A00h	1A00h	move to Y1=512

A description of these two examples will help the user understand the vector plotting process. Step 1 defines the vector attributes for the vectors to be plotted by the 1345A. Definition of a starting point is crucial when plotting vectors. Steps 2 and 3 initialize the starting point of the box. Next a new Y value is received indicating that the beam be turned on. Since the X value didn't change, only a new Y value need be sent. The beam will move to the location specified by the X-Y location when the Y value is received. The vector is drawn according to the status of the last Set Condition command.

When a new horizontal location is required, both the X and Y coordinates need to be sent to the 1345A. The beam is only moved and the vector drawn when a Y coordinate is received. The Y value doesn't change going from step 4 to step 5, but the X value does. This requires that a new X-Y coordinate pair be sent to the 1345A as in steps 5 and 6. In step 7, the X value doesn't require a change so only a new Y value is sent in step 7. The beam is turned on to draw the vector. In steps 8 and 9 a new X-Y pair is required so both values must be sent. To draw figure 3-11, only steps 4 and 7 need to be changed. The beam status bit tells the 1345A to turn the beam off during the movement. A vector is still drawn, but with the beam turned off.

The user should notice that when a vector is to be drawn vertically, only a Y value is sent for the second vector endpoint. The 1345A has a "last X" register that stores the value of the last X location. This feature allows vertical vectors with the same X values to be drawn with one less endpoint requirement.

When plotting vectors in the vector drawing area, the user should take into account the difference in CRT screen height and width. The 1345A vector drawing area is 8.5 cm high by 11.5 cm wide and has 2048 addressable points in either direction. If this difference is not taken into account, boxes will appear as rectangles. To plot vectors correctly, the user may need to apply a scaling factor to vector endpoint calculations. The scaling factors for the 1345A are approximately 215.58 addressable points/cm in the Y direction and 163.84 addressable points/cm in the X direction. These figures are used when calculating the actual length of vectors in cm.

3. Graph Command (B14=0, B13=1).

The Graph command is very similar to the Plot command. The purpose of the Graph command is to allow plotting of vectors that have equal incremental X coordinates. In the Graph mode the 1345A will automatically increment the X coordinate after each Y coordinate is received. This allows single valued functions to be plotted in graph form with fewer endpoints than would be possible using X,Y coordinates for each data point.

With bit 15 set to zero and command bits 14 and 13 set to zero and one, respectively, the 1345A is commanded to either: (a) set the DELTA-X increment; or (b) move the beam to a specific X-Y location determined by the X increment and the Y coordinate.

The beam position may be moved with the beam either turned off or turned on. Beam status for the beam movement is established each time that a Y coordinate Graph command is received.

The Graph command will draw all vectors according to the display configuration established by the last Set Condition command received by the 1345A.

MSB															LSB
B15	B14	B13	B12	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0
0	0	1	XY	PC	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
					DATA										

B14=0, B13=1: Graph Command.

XY 0 = set automatic DELTA-X increment (as specified by D0 - D10) for all subsequent Y coordinate Graph commands received.
1 = Y coordinate (as specified by D0 - D10) to which the beam is to be moved in conjunction with the DELTA-X increment.

PC (Beam Control Bit)
0 = Move (beam off)
1 = Draw (beam on)

There are three command modifiers in the Graph command. These modifiers control the X increment, Y coordinate data value, and the beam status. When B12 is 0, the data in bits D0-D10 define the value of the X increment. This is the amount the X coordinate will increment after each Y coordinate is plotted. The range of the X increment is 0 to 2047. It should be noted that X increases relative to present X,Y coordinate values on the screen. Figure 3-12 contains an example of the Graph mode commands. The beam moves when the Y coordinate value is received.

Example 1:
To graph, first move the beam to a starting position P1 (Plot Commands: X value; Y value with beam off). Then send the 1345A:

1) DELTA-X Graph command.
2) Y1 Graph command with the beam on. This moves the beam to point G1.
 Note that there is no DELTA-X increment with the first Y Graph command.
3) Y2 Graph command with the beam on. This moves the beam to point G2.
4) Y3 Graph command with the beam on. This moves the beam to point G3.
5) Y4 Graph command with the beam on. This moves the beam to point G4.

This will give a picture as shown below.

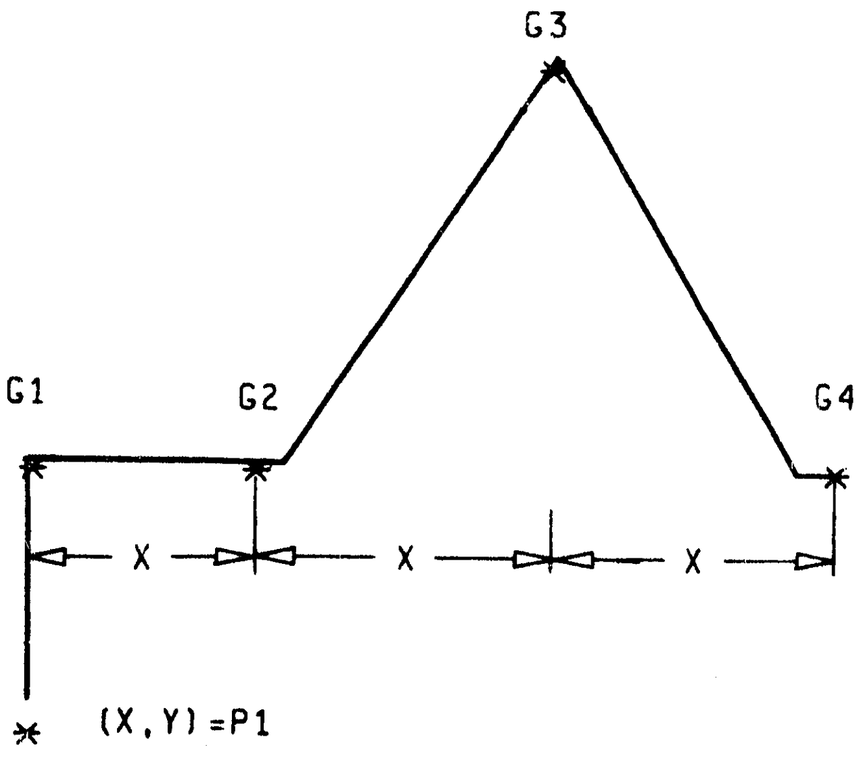


Figure 3-12. Graphing Example

To create the output in figure 3-12, the following steps were executed with the given 16-bit HEX data.

Command Step	16 Bit Data	1345A
1. Set Condition	7818h	Set Vector Attributes (Solid Full Bright, .05)
2. Plot X1	0200h	X=512
3. Plot Y1 (beam off)	1200h	move to Y=512
4. Graph command Set Delta X	2040h	set X increment to 64
5. Graph command Y1	3280h	Y=640
6. Graph command Y2	3280h	Y=640
7. Graph command Y3	3300h	Y=768
8. Graph command Y4	3280h	Y=640

Step 1 defines the line type, speed, and intensity. Steps 2 and 3 determine the starting point of the graph. The delta X increment is established in step 4. The (4) Y values are sent in steps 5-8. The value of X is incremented AFTER each Y value is received.

If the graph is to start at the axis origin, then execute a graph command with a first Y value set to zero. This will not plot anything, but will increment the X value by delta X. The next vector will be drawn from the origin to the Y value for the first X increment. If the graph is to start at the Y axis, then execute a Y value command. The next vector will be drawn from the Y value on the Y axis to the Y value of the first X increment.

Example 2.
Figure 3-13 shows how 15 vectors are drawn with only 20 commands. The sequence is described below:

Step 1 — Set Condition to define line type.

Step 2 — Plot command to set X location at lower left corner of graph.

Step 3 — Plot command to set Y location at lower left corner of graph.

Step 4 — Graph command to set X increment value. This value is referenced to the X axis of the graph.

Step 5 — Graph command with beam off and Y value set to 0. This will not plot anything, but is used to initiate the X increment to point 1.

Step 6 — Graph command with beam on and Y value set to point 1.

Step 7 — Graph command with beam on and Y value set to point 2.

•

• (send only Y values of points 3 through 14)

•

Step 20 — Graph command with beam on and Y value set to point 15.

Normal X,Y plot mode would require 33 commands to construct the same graph. Note that the above command sequence does not include generation of the graph axis, only construction of the graph itself.

The construction of a graph can have two forms. The vectors may start at either the origin or somewhere along the Y axis of the graph. If the origin is the starting point, then the user needs to set the first Y value to zero. This will not plot anything but will start the graph at the origin and increment the X value by one. When the next Y value is sent, a vector will be drawn from the origin to the new Y value. If the Y axis is the starting point then the user needs to send the first Y value with the beam off. This will insure that the axis of the graph is not altered by the line type set for the graph trace. For the next Y value the beam should be turned on.

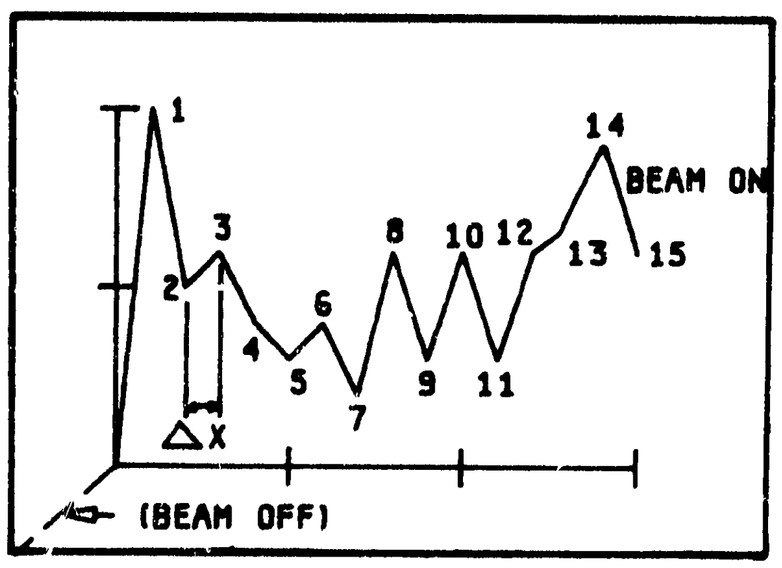


Figure 3-13. Graph Mode Example

4. Text Command(B14=1, B13=0).

The 1345A comes complete with an internal character generator. This internal character data is a modified ASCII character set for graphics use. The 1345A also contains many special characters that facilitate graphics and display annotation. Figure 3-14 contains the modified 1345A ASCII character set in HEX format. When the Text command is executed the 1345A will interpret the lower eight data bits D0-D7 as an equivalence for ASCII or special characters.

Instead of specifying a character to be drawn, the Text command character code can be replaced by a beam movement control code. These codes that move the beam (with the beam off) are Carriage Return (CR), Line Feed (LF), Inverse Line Feed, Backspace (BS),1/2 shift up, and 1/2 shift down. The amount and direction of beam movement depends on the character size and orientation specified. Line Feed and Inverse Line Feed provide automatic spacing between lines of text (spacing=height of one character between lines).

With bit 15 set to zero and command bits 14 and 13 set to one and zero, respectively, the 1345A is commanded to draw all the vectors necessary to produce the character specified.

The 1345A automatically provides a space to the right of each character for character spacing.

The Text command will draw the character according to the display configuration established by the last Set Condition command received by the 1345A. The characters are always drawn at the slowest writing speed. The line type has no visible effect except on the largest character size, (2.5X). The position is defined by the last X and Y coordinates received by the 1345A.

1345A MODIFIED ASCII CODE CONVERSION TABLE

LEAST SIGNIFICANT CHARACTER	MOST SIGNIFICANT CHARACTER 0	1	2	3	4	5	6	7
0		centered *	SP	0	@	P	`	p
1	HP logo	centered o	!	1	A	Q	a	q
2	β	↑	"	2	B	R	b	r
3		←	#	3	C	S	c	s
4	upper-half tic	↓	$	4	D	T	d	t
5	lower-half tic	→	%	5	E	U	e	u
6	left-half tic	√	&	6	F	V	f	v
7	right-half tic	π	'	7	G	W	g	w
8	back space	Δ	(	8	H	X	h	x
9	1/2 shift down	μ	)	9	I	Y	i	y
A	line feed	° (degree)	*	:	J	Z	j	z
B	inv. line feed	Ω	+	;	K	[	k	{
C	1/2 shift up	ρ	,	<	L	\	l	¦
D	carriage return	Γ	-	=	M	]	m	}
E	horizontal tic	θ	.	>	N	^	n	□
F	vertical tic	λ	/	?	O	—	o	►

EXAMPLES:

HP logo	=	01
A	=	41
i	=	69
√	=	16
►	=	7F
line feed	=	09

Figure 3-14. 1345A Modified ASCII Character Set

The Text command has command modifiers for size and rotation information. New size and rotation information is controlled by the status of data word bit B8. To initiate new character attributes, bit B8 must be set high as a new information indicator. If the data bit is "0", the size and rotation bits are ignored.

The 1345A has 4 character sizes. These 4 sizes are defined by the status of bits B11 and B12. The amount of space needed to draw the characters is contained in figure 3-15. This is the required space needed out of 2048 X 2048 possible points. The number of characters that can be drawn across the screen at different sizes in in figure 3-16. An example of 1X character spacing is contained in figure 3-17.

When the 1345A has finished drawing a character it automatically advances the beam to the starting point for the next character. In this way the 1345A functions much like a typewriter when presenting text.

The modified ASCII character set for the 1345A is shown in table 3-1.

Table 3-1. 1345A Character Set

0		32	Space	64	@	96	` NOTE 2
1	HP logo	33	!	65	A	97	a
2	beta	34	"	66	B	98	b
3		35	#	67	C	99	c
4	upper-half tic	36	$	68	D	100	d
5	lower-half tic	37	%	69	E	101	e
6	left-half tic	38	&	70	F	102	f
7	right-half tic	39	'	71	G	103	g
8	back space	40	(	72	H	104	h
9	1/2 shift down	41	)	73	I	105	i
10	line feed	42	*	74	J	106	j
11	inv. line feed	43	+	75	K	107	k
12	1/2 shift up	44	,	76	L	108	l
13	carriage return	45	-	77	M	109	m
14	horizontal tic	46	.	78	N	110	n
15	vertical tic	47	/	79	O	111	o
16	centered *	48	0	80	P	112	p
17	centered o	49	1	81	Q	113	q
18	up arrow	50	2	82	R	114	r
19	left arrow	51	3	83	S	115	s
20	down arrow	52	4	84	T	116	t
21	right arrow	53	5	85	U	117	u
22	square root	54	6	86	V	118	v
23	pi	55	7	87	W	119	w
24	delta	56	8	88	X	120	x
25	mu	57	9	89	Y	121	y
26	° (degree)	58	:	90	Z	122	z
27	ohm	59	;	91	[	123	{
28	rho	60	<	92	\	124	\|
29	gamma	61	=	93	]	125	}
30	theta	62	>	94	^	125	box
31	lamda	63	?	95	— NOTE 1	127	shaded triangle

NOTES: 1. 95 = Underline character with Auto Back Space
2. 96 = Slanted in opposite direction of character 39.

MSB B15	B14	B13	B12	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1	LSB B0
0	1	0	S1	S0	R1	R0	ES	D7	D6	D5	D4	D3	D2	D1	D0
								←——CHARACTER——→							

B14=1, B13=0: commands that the 1345A display a text character (specified by D0-D7).

ES (Establish size of character)
0 = use previous size and rotation
1 = establish new size and rotation according to S1-S0 and R1-R0

R1	R0	(Character Rotation (CCW))
0	0	0 degrees
0	1	90 degrees
1	0	180 degrees
1	1	270 degrees

S1	S0	Size	Width X Height (in addressable points)
0	0	1 X	24 X 36
0	1	1.5 X	36 X 54
1	0	2 X	48 X 72
1	1	2.5 X	60 X 90

Figure 3-15. Text Command Bit Pattern

PROGRAMMABLE CHARACTER SIZES:

1.0 X 56 characters per line, 28 horizontal lines possible.
1.5 X 37 characters per line, 18 horizontal lines possible.
2.0 X 28 characters per line, 14 horizontal lines possible.
2.5 X 22 characters per line, 11 horizontal lines possible.

Figure 3-16. 1345A Character Display Capabilities

Example:

1 X character spacing (in addressable points)

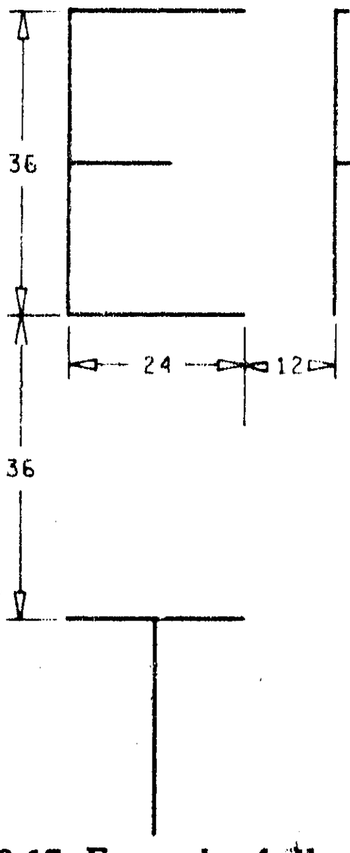


Figure 3-17. Example of Character Spacing

Character rotation is an additional feature of the 1345A. The 1345A can be programmed to rotate any character at 0, 90, 180, or 270 degrees rotation measured counter clockwise from horizontal. This can be done for any character at any size. The starting point of the character is always the lower left corner relative to any rotation. For character rotation, the entire character area is rotated the specified number of degrees and the starting point moves around in a counter clockwise fashion. For example, the starting point of a character rotated 180 degrees would be the upper right corner. this technique is illustrated in figure 3-18.

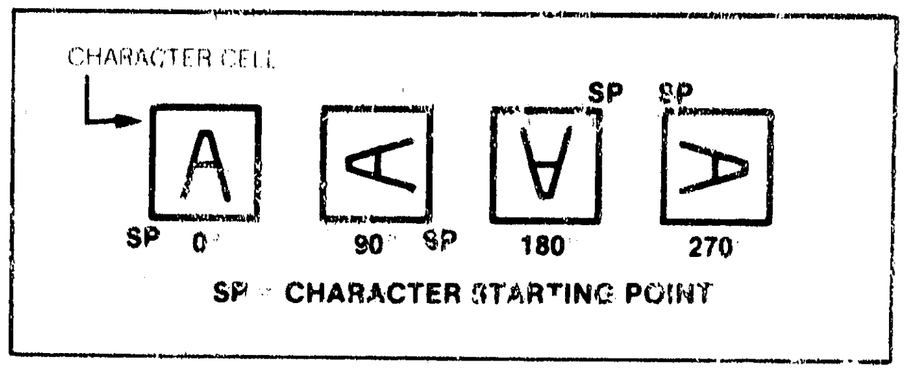


Figure 3-18. Character Rotation

Since the starting point of the character changes with rotation, so does the direction of character spacing. If the rotation is 180 degrees, the characters will be written upside down from right to left. If the rotation mode is 270 degrees, the characters will advance from top to bottom. Rotation spacing examples are contained in figure 3-19.

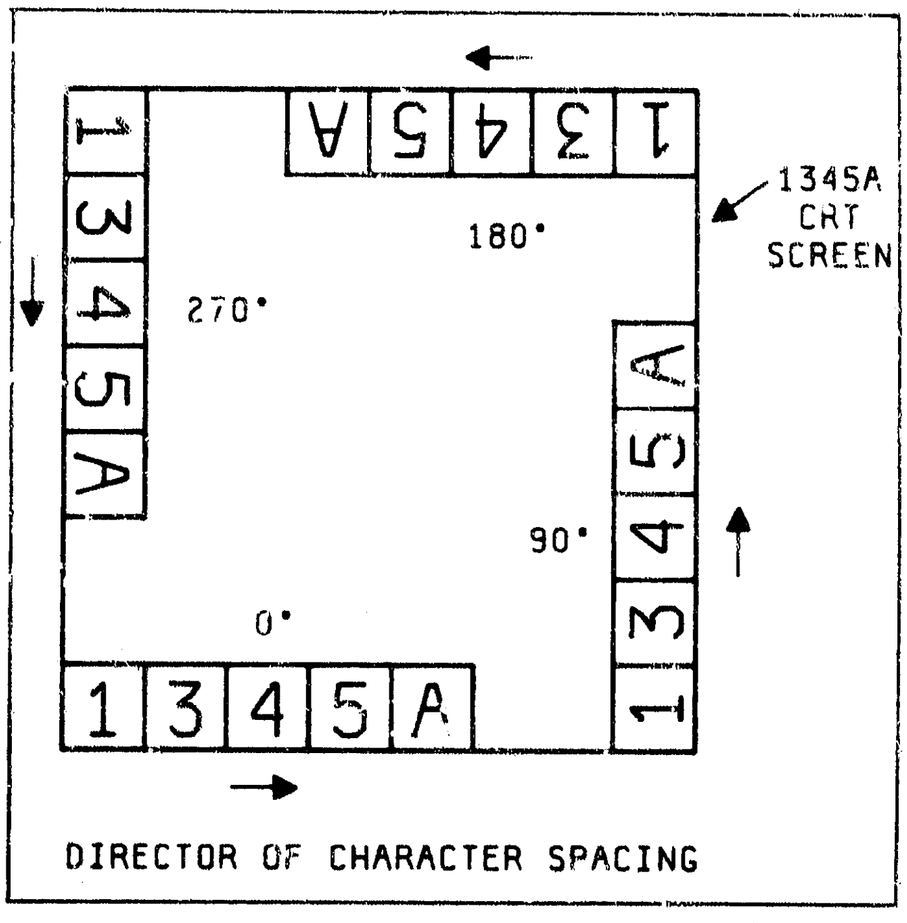


Figure 3-19. Character Rotation Spacing

5. Calculating the Starting Point for Text.

If we wish to display the characters "1345A" in the center of the display, proceed as follows.

Let's choose the 2.5X (largest) character size. Each character will be 90 X 90 addressable points.

Calculation:

center screen = 1024,1024 (X,Y)

X = 1024 — (2.5 chars. X 90 points/char.)
= 1024 — 225
= 799
Y = 1024 — (0.5 char. X 90 points/char.)
= 1024 — 45
= 979

Send the 1345A a Plot X command with X=799. The HEX code to do this is 031F.

Send the 1345A a Plot Y command with the beam off and Y=979. The HEX code to do this is 13D3.

Then send the Text commands to produce each of the characters.

6. Wraparound.

The characters listed in figure 3-20 cause wraparound if positioned too close to the edge of the Vector Drawing area. Wraparound appears as vectors drawn completely across the display. This condition can also be caused by vectors drawn outside the screen area.

It is important to observe the recommended character boundary specifications, to avoid problems which might be encountered by writing at the screen edges. Figure 3-21 contains recommended limits for each character size at each screen edge. Failure to observe these limits may result in undefined results, particularly when writing characters listed in figure 3-20. The user should plot all characters within the specified borders. The user should not attempt to write any characters along a screen edge. The character spacing guidelines in figure 3-21 allow ample spacing for characters of all specified sizes. Characters NOT specified in figure 3-20 may be written closer to the screen borders but it is not recommended.

CHARACTER				CHARACTER			
No.	Description	HEX	Boundary Affected	No.	Description	HEX	Boundary Affected
1	HP Logo	01	Right,Top	36	$	24	Top,Bottom
2	beta	02	Bottom	40	(	28	Top,Bottom
4	upper-half tic	04	Top	41	)	29	Top,Bottom
5	lower-half tic	05	Bottom	44	,	2C	Bottom
6	left-half tic	06	Left	56	8	38	Top
7	right-half tic	07	Right	59	;	3B	Bottom
8	back space	08	Left	81	Q	51	Bottom
9	1/2 shift down	09	Bottom	91	[	5B	Top,Bottom
10	line feed	0A	Bottom	93	]	5D	Top,Bottom
11	inv. line feed	0B	Top	95	— (underline)	5F	Bottom
12	1/2 shift up	0C	Top	103	g	67	Bottom
14	horizontal tic	0E	Left,Right	106	j	6A	Bottom
15	vertical tic	0F	Left,Bottom	112	p	70	Bottom
16	centered *	10	Left,Bottom	113	q	71	Right,Bottom
17	centered o	11	Left,Bottom	121	y	79	Bottom
22	square root	16	Right,Top	123	{	7B	Top,Bottom
25	mu	19	Bottom	125	}	7D	Top,Bottom
26	°(degree)	1A	Top	126	box	7E	Right,Top
28	rho	1C	Bottom				

Figure 3-20. Wraparound Characters and Boundaries

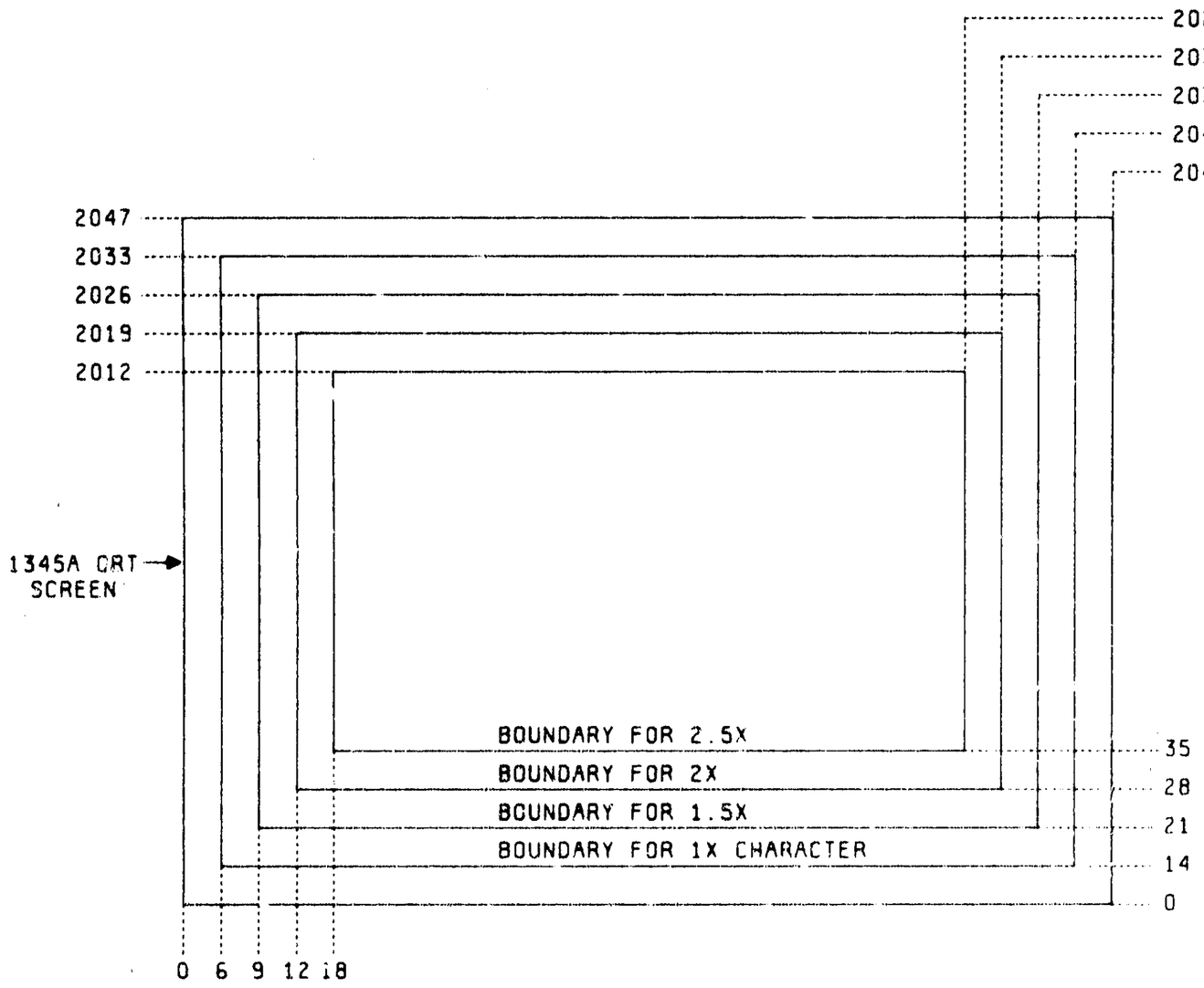


Figure 3-21. Character Borders

3-10. REFRESH REQUIREMENTS

The user processor must present all picture data to the 1345A at a minimum rate of approximately 50 Hz. Below a 50 Hz refresh rate the display may begin to flicker. Recommended refresh rate is approximately 60 HZ.

3-11. Potpourri

1. Octal and Hexadecimal Ranges for 1345A Commands.

1345A Command	Octal Range	Hexadecimal Range
Plot		
X	00000 - 07777	0000 - 0FFF
Y (beam off)	10000 - 13777	1000 - 17FF
Y (beam on)	14000 - 17777	1800 - 1FFF
Graph		
Set DELTA-X	20000 - 27777	2000 - 2FFF
Y (beam off)	30000 - 33777	3000 - 37FF
Y (beam on)	34000 - 37777	3800 - 3FFF
Text	40000 - 57777	4000 - 5FFF
Set Condition	60000 - 77777	6000 - 7FFF

2. Optimizing Picture Quality.

Due to differing conditions of ambient light when the 1345A is displaying pictures, the programmer may have to experiment with the Intensity and Writing Speed parameters of the Set Condition command.

For example, in an environment of high ambient light, the 1345A should be set to the highest brightness level and slowest writing speed.

3. Reducing Display Flicker.

The 1345A must receive all data for the picture from the user processor at an approximate rate of once every 16.7 milliseconds (60 Hz refresh rate).

A long vector may require up to 100 microseconds before the 1345A will receive the next command (vector) from the user processor. If the 1345A is drawing a picture with many long vectors, then the refresh rate can be slowed to the point where the operator will perceive flicker.

3-12. 1345A DIGITAL DISPLAY IMPLEMENTATION.

The choice of user system microprocessor and complexity of the user interface depends on the capabilities required of the user instrument and the other tasks the microprocessor must perform. We will discuss three basic types of display interface techniques, as illustrated in figure 3-22. When interfacing the 1345A to a user instrument, one of these three basic interfaces will probably be used. Each type of interface will be discussed highlighting advantages, disadvantages and example applications where each type of interface might be used.

3-13. SIMPLE INTERFACE.

The simplest type of interface that can be constructed for the 1345A is a single microprocessor system. In this type of system the interface is part of the microprocessor address space and the entire instrument is controlled by a single processor. Typical application characteristics for this type of interface are low system overhead, semi-static display, and slower data transfer rate. This would be a good type of interface for an instrument that displays linear data thus utilizing the graph mode of the 1345A. In graph mode, less vectors are required to create linear displays. A block diagram of an example single processor interface is contained in figure 3-23.

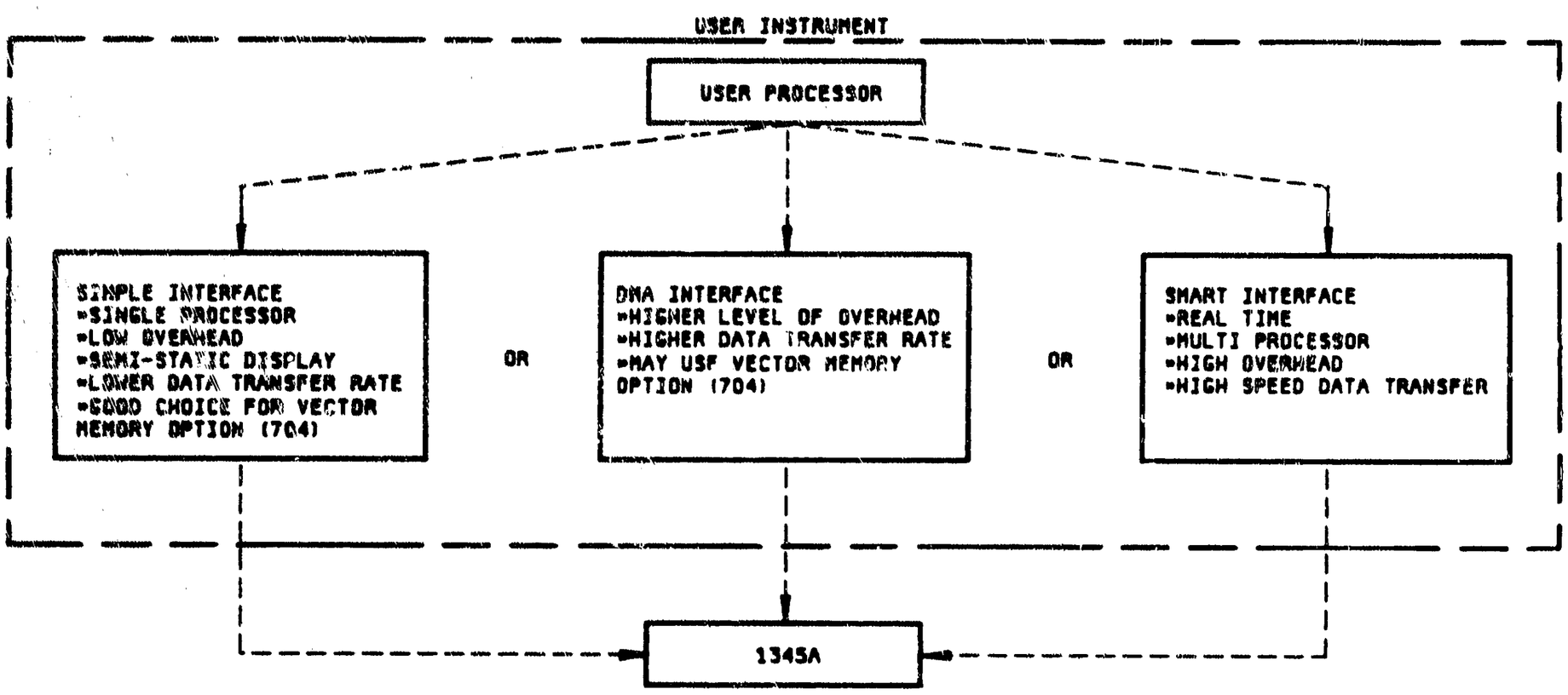


Figure 3-22. 1345A Interfacing Techniques

The vector memory board would be a good choice for this type of interface. If the memory option is not used, the number of vectors that can be displayed is limited by the amount of time the user processor has to update the display. Typically this will be only a few hundred vectors. If the memory option is used, display data is stored in the vector memory which will handle the display refresh requirements. The number of vectors that can be displayed is limited by the total vector length capabilities of the 1345A. Use of the memory option board in this situation will enhance the overall system performance.

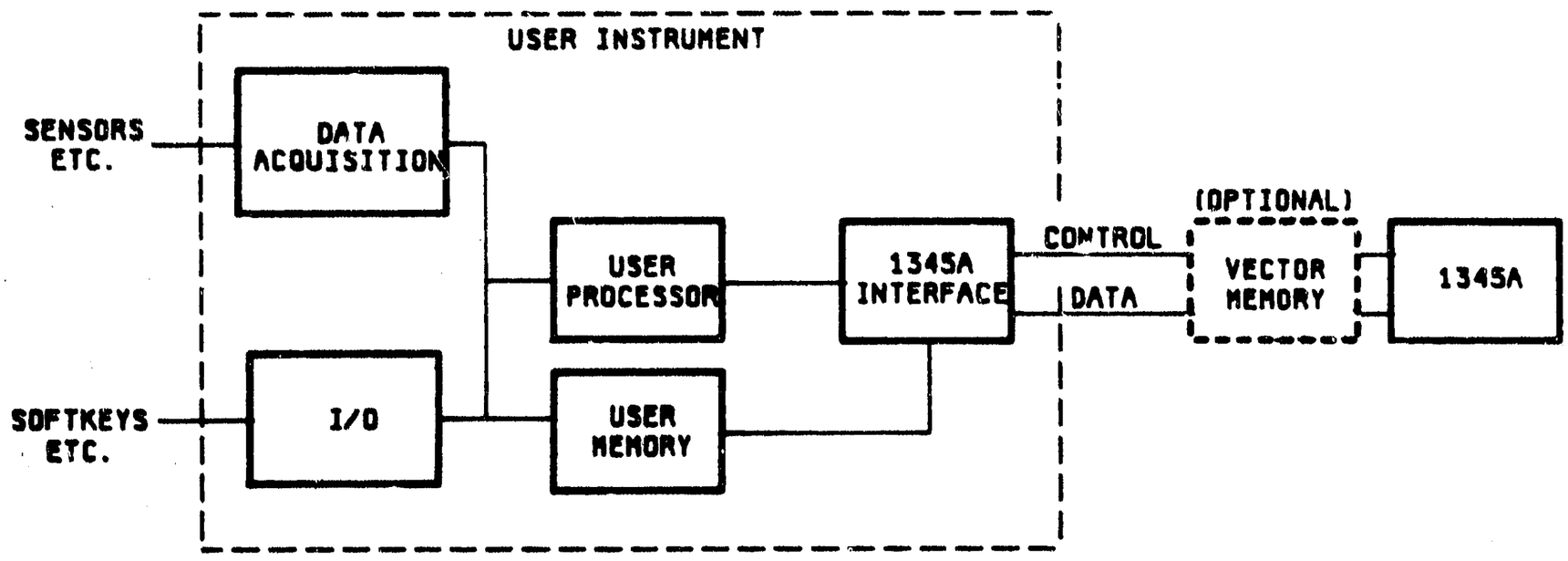


Figure 3-23. Single Processor Interface

SAFETY

This product has been designed and tested according to International Safety Requirements. To ensure safe operation and to keep the product safe, the information, cautions, and warnings in this manual must be heeded. Refer to Section I and the Safety Summary for general safety considerations applicable to this product.

CERTIFICATION

Hewlett-Packard Company certifies that this product met its published specifications at the time of shipment from the factory. Hewlett-Packard further certifies that its calibration measurements are traceable to the United States National Bureau of Standards, to the extent allowed by the Bureau's calibration facility, and to the calibration facilities of other International Standards Organization members.

WARRANTY

This Hewlett-Packard product is warranted against defects in material and workmanship for a period of one year from date of shipment. During the warranty period, Hewlett-Packard Company will, at its option, either repair or replace products which prove to be defective.

The cathode-ray tube (CRT) in the instrument and any replacement CRT purchased from HP are also warranted against electrical failure for a period of one year from the date of shipment from Colorado Springs. BROKEN TUBES AND TUBES WITH PHOSPHOR OR MESH BURNS, HOWEVER, ARE NOT INCLUDED UNDER THIS WARRANTY.

For warranty service or repair, this product must be returned to a service facility designated by HP. However, warranty service for products installed by HP and certain other products designated by HP will be performed at Buyer's facility at no charge within the HP service travel area. Outside HP service travel areas, warranty service will be performed at Buyer's facility only upon HP's prior agreement and Buyer shall pay HP's round trip travel expenses.

For products returned to HP for warranty service, Buyer shall prepay shipping charges to HP and HP shall pay shipping charges to return the product to Buyer. However, Buyer shall pay all shipping charges, duties, and taxes for products returned to HP from another country.

LIMITATION OF WARRANTY

The foregoing warranty shall not apply to defects resulting from improper or inadequate maintenance by Buyer, Buyer-supplied software or interfacing, unauthorized modification or misuse, operation outside of the environmental specifications for the product, or improper site preparation or maintenance.

NO OTHER WARRANTY IS EXPRESSED OR IMPLIED. HP SPECIFICALLY DISCLAIMS THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

EXCLUSIVE REMEDIES

THE REMEDIES PROVIDED HEREIN ARE BUYER'S SOLE AND EXCLUSIVE REMEDIES. HP SHALL NOT BE LIABLE FOR ANY DIRECT, INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, WHETHER BASED ON CONTRACT, TORT, OR ANY OTHER LEGAL THEORY.

ASSISTANCE

Product maintenance agreements and other customer assistance agreements are available for Hewlett-Packard products.

For any assistance, contact your nearest Hewlett-Packard Sales and Service Office. Addresses are provided at the back of this manual.

S C W & A 9/78 (CRT)

3-14. DMA INTERFACES.

A DMA interface allows the transfer of data to the 1345A to occur without using up user processor time. This type of interface requires the user processor set up the transfer but not control it. The DMA circuitry on the interface will control the transfer. This allows the user processor to start a data transfer and then go process other tasks such as keyboard scanning, data acquisition, etc. A system that does all these functions needs to have a data transfer technique that leaves the user processor free to perform these other functions. The method in this case is DMA with or with-out Optional Vector Memory. It is possible for the user instrument to make use of both a DMA interface and the vector memory. In this case the user processor would initiate a DMA transfer to the memory. The memory would then handle all refresh requirements independent of the user processor. The only display overhead would be when the user processor needs to send new data to the 1345A. The entire 4096 locations of the vector memory can be written in less than 3 ms. The user interface could hold off one 16.6 ms refresh cycle and rewrite the new data into the memory. If the optional Vector Memory is not used, the user interface must have access to a selected area of memory set aside for display data and a timer that schedules refresh cycles. When a DMA request is activated, the user interface will access the display memory and write this data to the 1345A without user processor intervention. An example DMA interface is illustrated in the block diagram in figure 3-24. The advantages of this type of interface are low overhead to the user processor and faster data transfer rates. The disadvantage is that the interface is harder to construct and configure into a processor system than the simple interface. Typical applications for this type of interface are interactive systems with dynamic displays of continuous data acquisition.

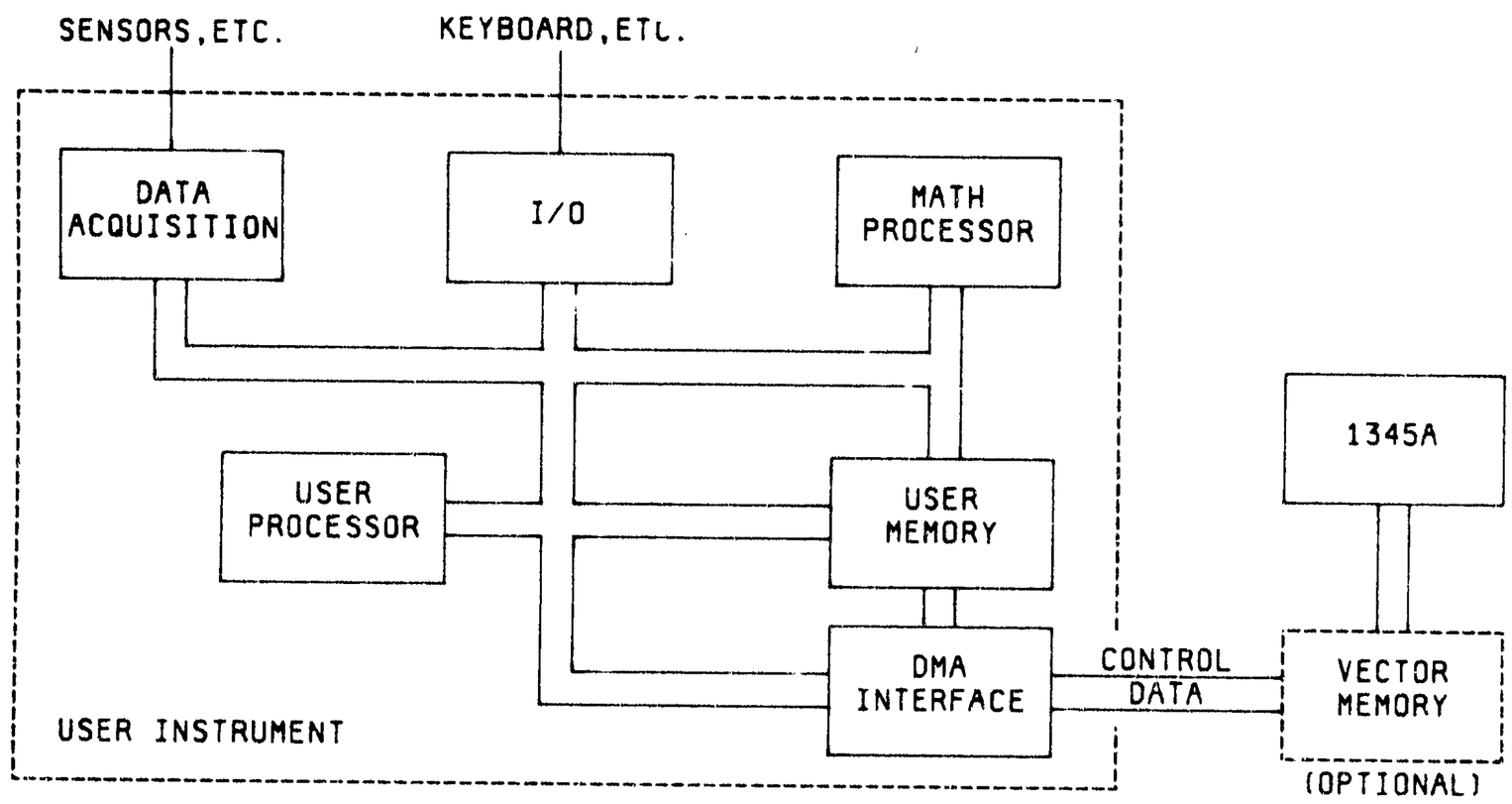


Figure 3-24. DMA Interface

3-15. SMART INTERFACE.

This type of interface is intended for the user who requires maximum display performance. An interface of this variety is custom designed to maximize data transfer from the user instrument input to display output. These type of instruments are usually driven by several microprocessors, each having a limited number of tasks. A typical 1345A interface for this type of instrument would contain smart hardware or a dedicated microprocessor. This interface would control refresh timing and data transfer to the 1345A. The user processor in the instrument would not need to handle any data transfer tasks.It would be advantageous to the user to have the interface utilize a high speed dual port memory to minimize data transfers. Figure 3-25 contains a block diagram of this type of interface. A typical application for this type of interface would be a Real Time measurement instrument. Typically the data to be displayed is totally different each refresh cycle. The obvious advantage of this type of interface is speed. It is however, much more difficult to implement. The memory board would probably not be a good choice for this type of system.

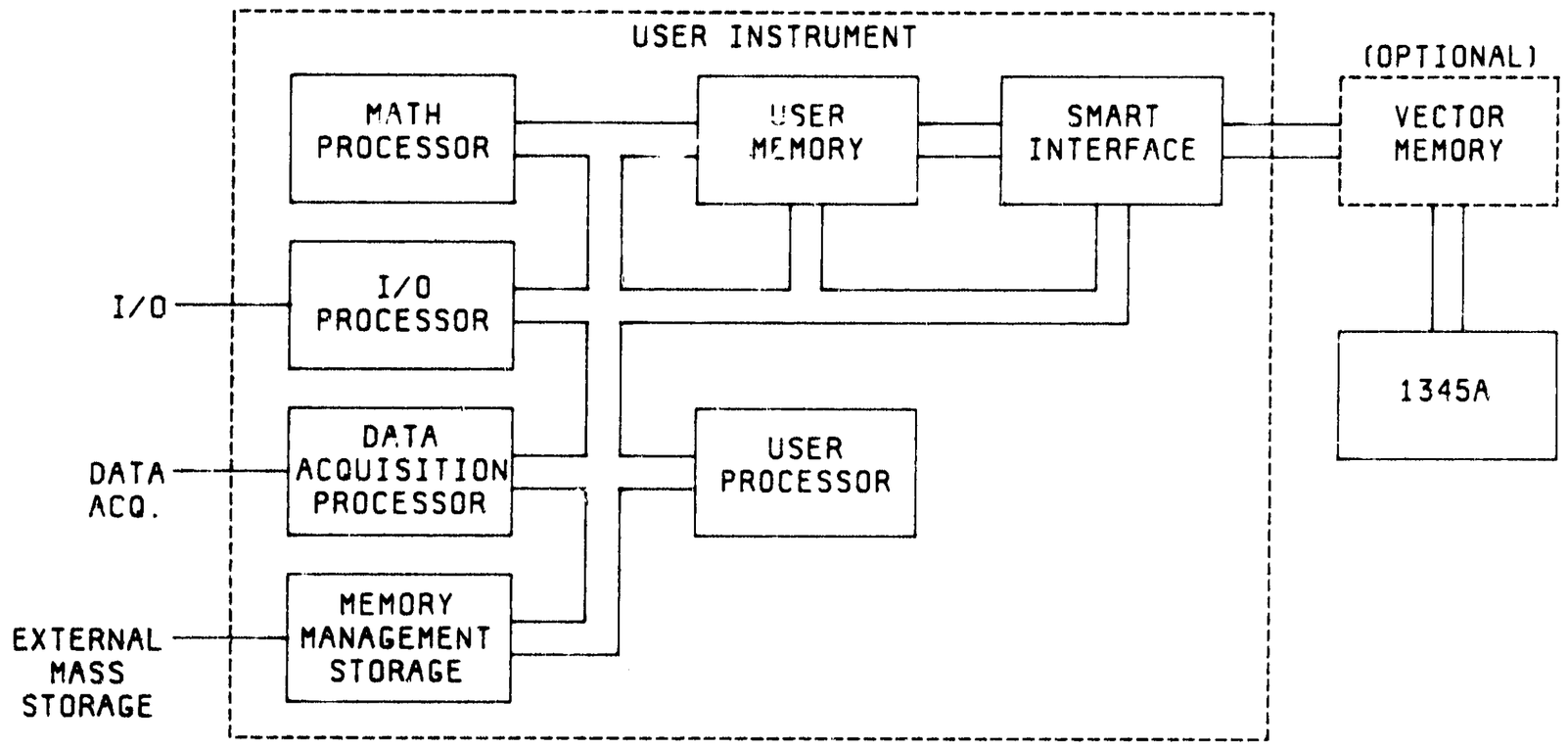


Figure 3-25. Example Smart Interface

3-16. OPERATION FOR OPTION 704.

3-17. DESCRIPTION

The 1345A memory option stores up to 4K, 16-bit commands and refreshes the CRT, thus relieving the user processor of data storage and CRT refresh requirements.

The memory option recognizes two commands for programming. These commands are for data transfer and memory address pointer manipulation. A data transfer is either a read from or a write to the Vector Memory. Address pointer operations are used for positioning the data in the Vector Memory list and selecting a desired memory read addr.

Figure 3-26 shows where the Vector Memory fits into the 1345A architecture.

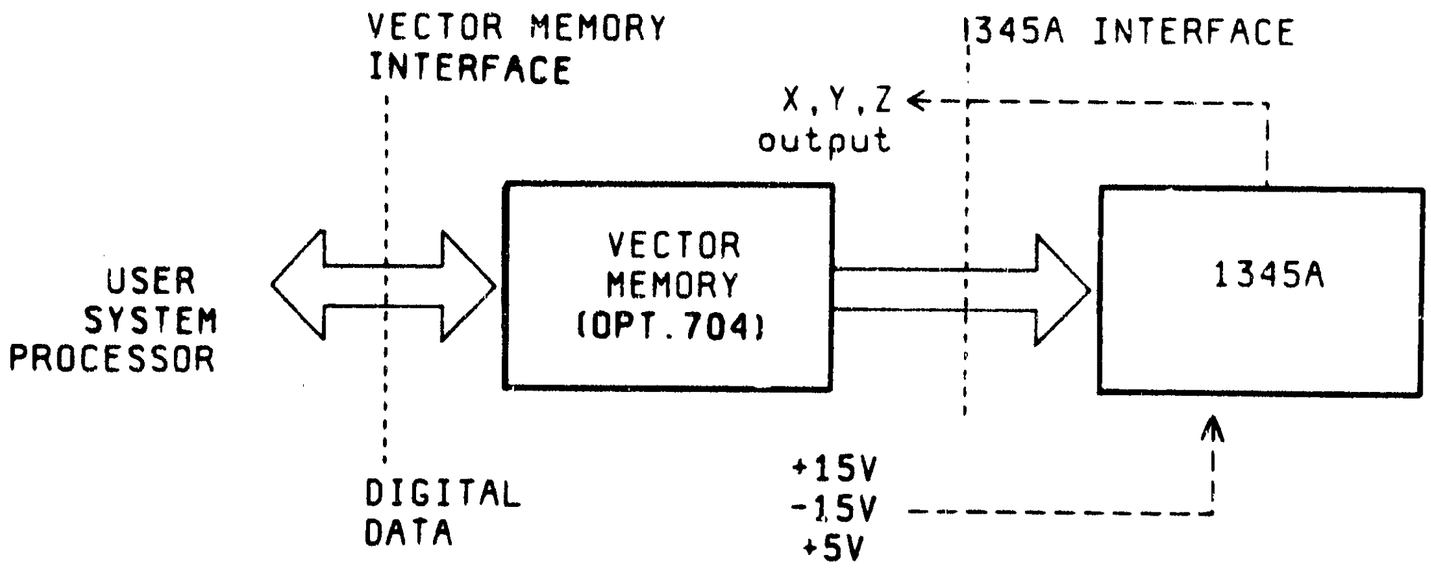


Figure 3-26. Vector Memory Interface (Option 704)

The user processor can send all picture-producing data to the Vector Memory at one time. The Vector Memory will then continuously refresh the display screen by redrawing the picture at regular intervals. This reduces overhead time for the user processor.

The user processor can access any address in the Vector Memory via the Vector Memory address pointer. This allows selected portions of a picture to be changed or sent back to the processor for checking or processing.

The Vector Memory also has a feature whereby the user processor can suppress portions of the picture (such as graticules or labels). Suppressed information is not erased from the Vector Memory. This is done by having the Vector Memory do an internal jump past the data that is not to be displayed. Suppressed data can be made part of the picture by using only a few user processor commands, thus reducing overhead time.

Vector Memory digital interface consists of:

1. A 16-bit bidirectional Data Bus.
2. A Read signal line LRD (input).
3. A Write signal line LWR (input).
4. A Device Select signal line LDS (input).
5. An Acknowledge signal line LACK (output - use is optional).
6. An External display Synchronization signal line SYNC (input - use is optional).

These signal lines are all explained under Signal Line Definitions. Timing diagrams for user processor interfacing are shown after Signal Line Definitions.

NOTE

When the 1345A is equipped with the Vector Memory, the 2-wire handshake (LRFD & LDAV) is not used. The signal lines used are LRD, LWR, and LDS.

3-18. VECTOR MEMORY MANAGEMENT.

Using the memory option (704) in a 1345A system requires some additional considerations not necessary with a standard 1345A. Figure 3-27 contains an example instrument block diagram with the memory option installed.

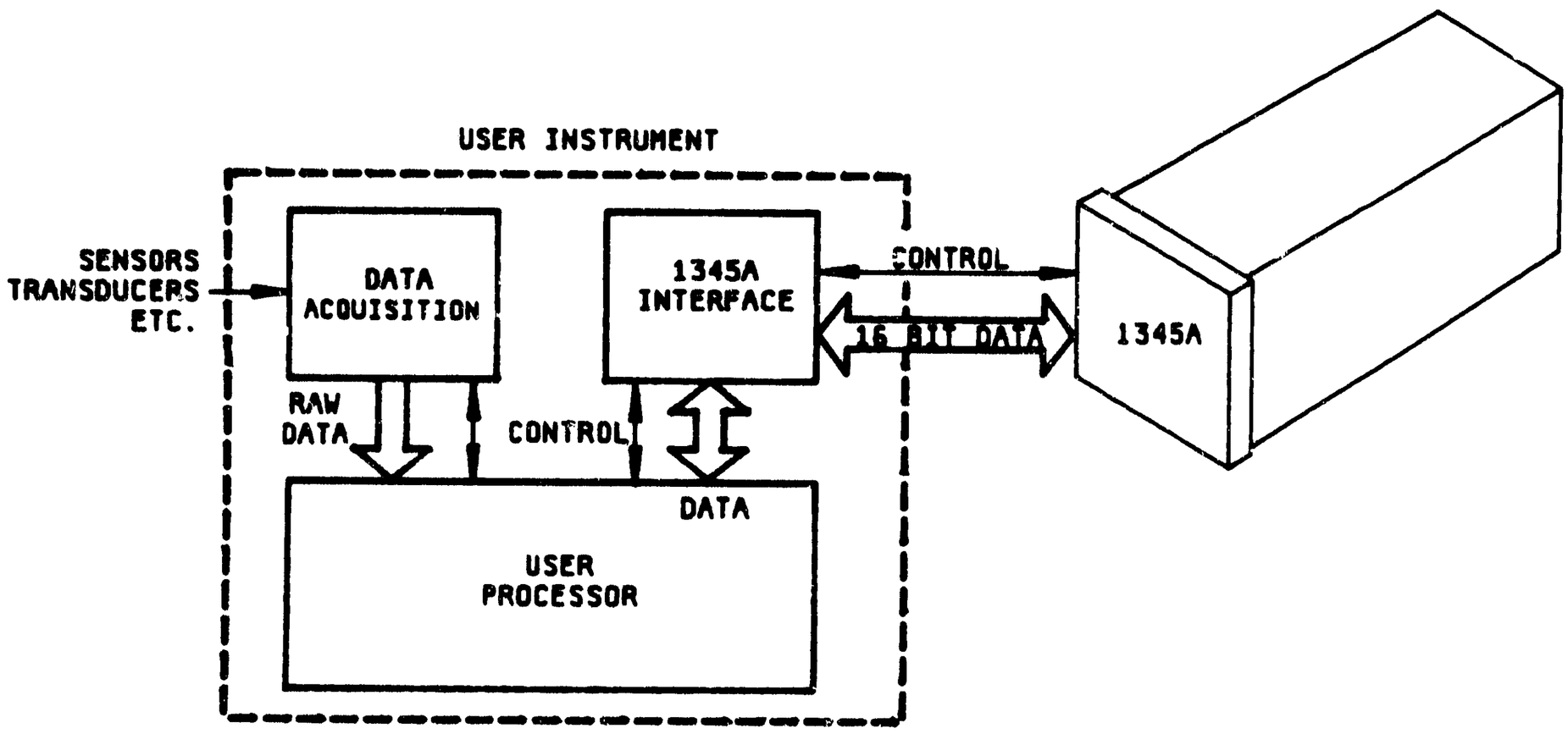


Figure 3-27. Example Instrument With Memory Option 704

The main advantage of the memory option is that it relieves the user processor from the task of display refresh. However, effective use of the memory option requires that the user have a memory management scheme for data transfer to and from the Vector Memory. An example memory map is shown in figure 3-28.

The memory map example has six data fields that can be displayed. The link in front of each data block contains a no-op and a jump command. A no-op is a zero word. This is equivalent to a plot X=0 command. If a picture data block is to be suppressed, then the link in front of that block will contain a jump address to a no-op of another link. If vector data contained in the data block is to be displayed, then the jump address will be the starting address of the data block. To alter the status of a block of picture data, the user processor needs to position the memory address pointer to the address of the link to be modified and write a jump command into the link with the new jump address. To alter data, the Vector Memory address pointer needs to be positioned to the starting address of the data block and the user processor then writes the display data into the Vector Memory. The length of each segment needs to be greater than or equal to the maximum amount of data to be

displayed from that segment. The user processor must insure that the data within each block is initialized and maintained so that erroneous data is not left in the data block when a new and smaller set of data is stored. The user can manage each block by putting a jump command at the end of the data that jumps to the link of the next data block. It is recommended that the user write a no-op into address 4095. Then 4095 can be used as a jump address from data blocks. This will also provide an easy method to use synchronous refresh. It should be noted that jumps can be forward or reverse within the Vector Memory.

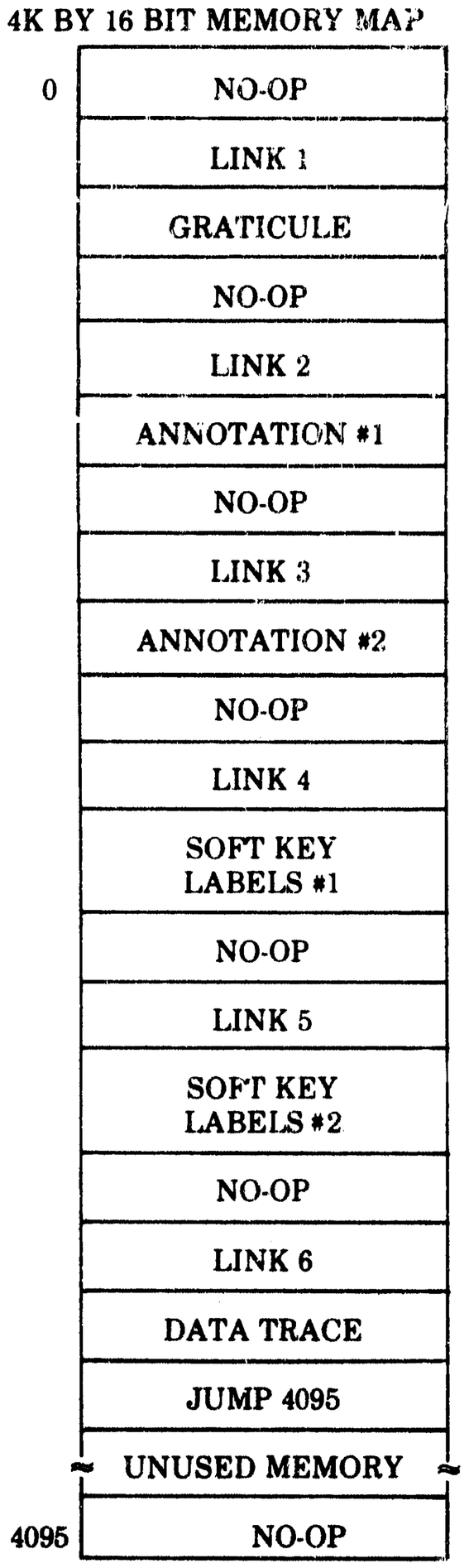


Figure 3-28.
Example Vector Memory Map

3-19. READING THE VECTOR MEMORY.

The data contained in the Vector Memory can be read by the user processor. This data may be used for additional data processing, external hard copy plotting, etc. This feature allows the user to read and verify the contents of the Vector Memory. This feature is activated by setting the LRD line to a low state while DS is low and reading the contents of the 1345A 16-bit data bus. The user needs to set the Vector Memory address pointer to the desired memory address and start the read process.

3-20. DISPLAY PERFORMANCE CONSIDERATIONS.

To obtain optimum performance from the 1345A Digital Display, there are a few performance parameters that need consideration. These are refresh rate, picture complexity and vector data rate.

3-21. REFRESH.

3-22. Introduction.

Each time that the picture is redrawn by the 1345A, the display is refreshed. This prevents the phosphor light output from expiring.

The Vector Memory sends its data to the 1345A (independent of the user processor) each time that the picture is to be drawn on the display.

The Vector Memory outputs its data to the 1345A either via synchronous or asynchronous operation.

a. Synchronous Refresh Mode.

Synchronous refresh mode is entered when the Vector Memory encounters an Internal Jump to 4095 after it has sent the picture to the 1345A.

In synchronous mode, the Vector Memory waits until a synchronizing (sync) pulse occurs before it will begin its next data output cycle to the 1345A.

The sync pulses can be either internal or external (set by moving a jumper located on the vector memory board).

Internal Sync: an on-board oscillator provides sync pulses at approximately a 60 Hertz rate.

External Sync: sync pulses (TTL) are supplied from an external source in the user system via the SYNC input signal line.

After the Internal Jump to address 4095 is executed, the Vector Memory waits until the next sync pulse before it will start a new refresh cycle.

b. Asynchronous (free-running) Refresh Mode.

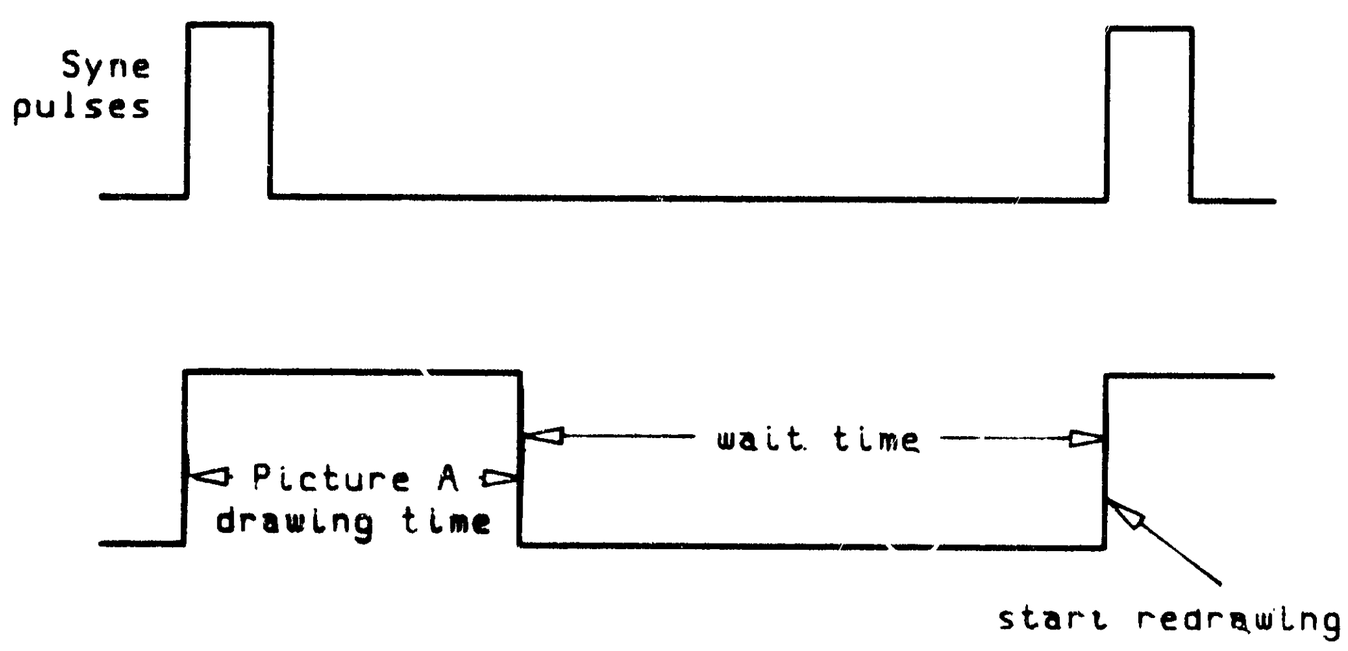
There are two cases where the Vector Memory overrides the sync pulses and refreshes the display asynchronously (in a free-running, continuous manner).

The first case is when the picture cannot be drawn in the time interval between sync pulses. When this occurs, sync pulses are ignored. Refresh rate is controlled by the time required for the Vector Memory to send all its data to the 1345A. Since longer vectors take more time to draw, the 1345A prevents the Vector Memory from sending its next word (to the 1345A) until the current vector is done.

The second case where the sync pulses are ignored occurs when Vector Memory address 4095 is reached during refresh without an internal jump to 4095. It is therefore recommended that the Vector Memory be made to jump to address 4095 at the end of picture data in order to minimize time between refresh cycles.

This sync override feature allows all simple pictures to be displayed at an even brightness (say 60 Hertz refresh rate), and complex pictures to be displayed at a level of brightness that depends only on the time it takes to draw the picture on the display.

(1) Synchronous refresh example (Jump to 4095 after picture).



Pictures A and B will be displayed at an even brightness (sync rate = refresh rate) even though picture A requires less drawing time.

Figure 3-29. Synchronous Refresh Example

(2) Asynchronous refresh example:

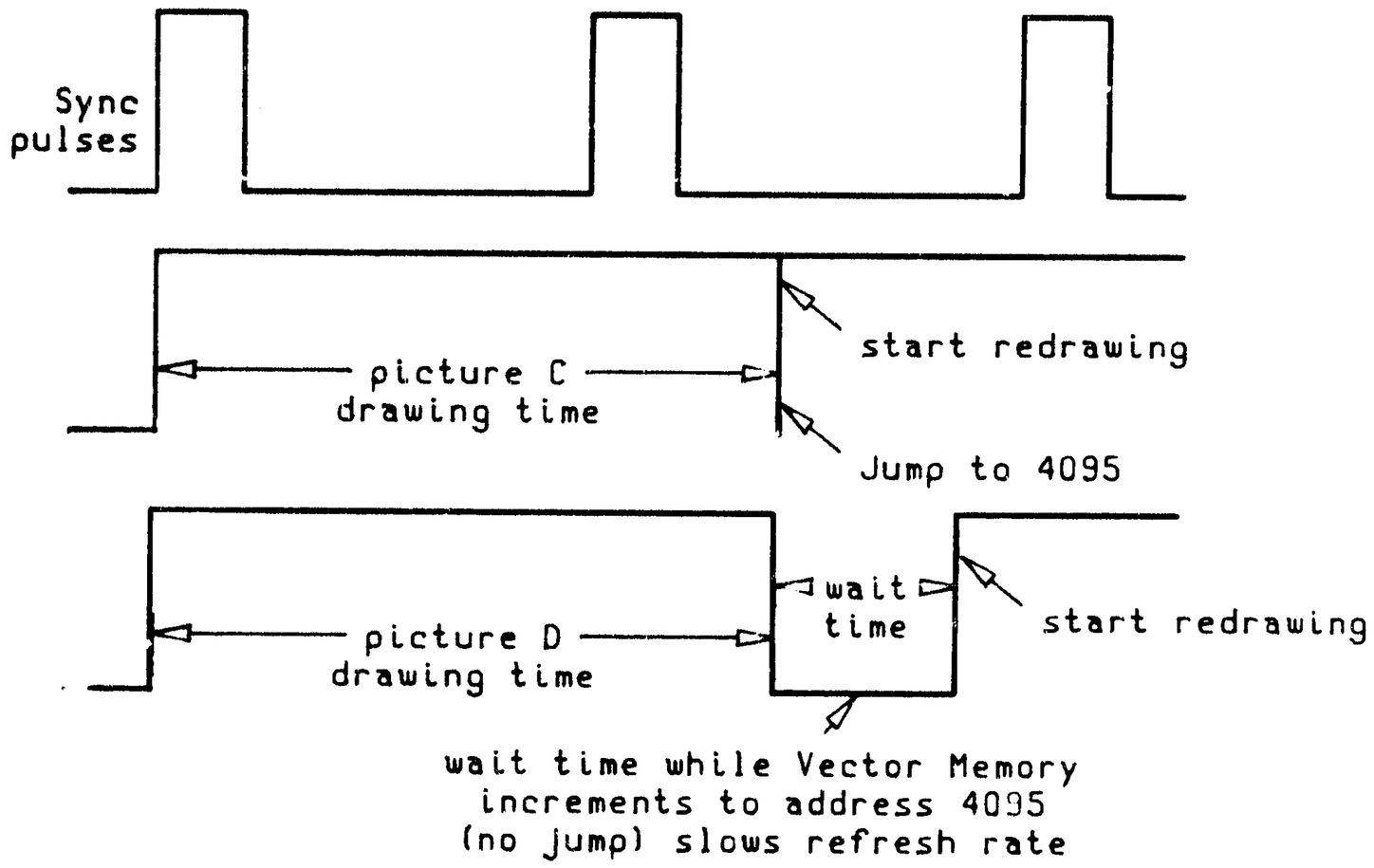


Figure 3-30. Asynchronous Refresh Example

3-23. PICTURE COMPLEXITY.

The degree of picture complexity is a direct function of the TOTAL LENGTH of vectors drawn on the 1345A display. Since ALL data to be displayed should be transmitted to the 1345A 60 times a second, three performance parameters require attention. These are the vector writing speed, average vector length, and the number of characters to be displayed.

The 1345A has the capability of drawing vectors at several writing speeds. Writing speed is defined as the speed at which the beam is deflected across the CRT screen. The 1345A has the capabilities contained in figure 3-31, which compares writing speed and maximum total vector length which the 1345A can draw at a 60 Hz refresh rate.

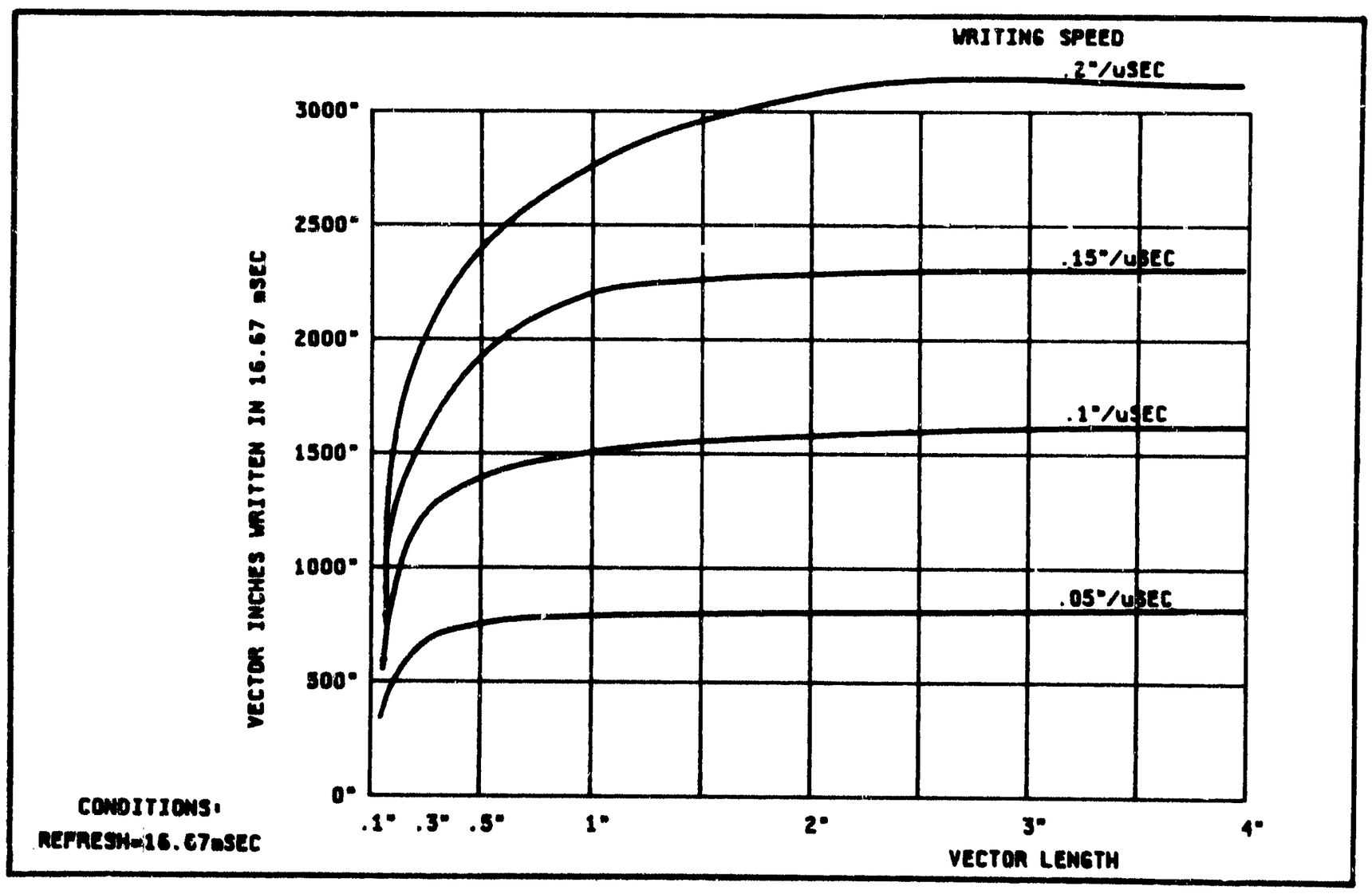


Figure 3-31. Vector Length vs Writing Speed for 60 Hz Refresh Rate

The specified number of vector inches in figure 3-31 can be written with a refresh cycle time of 16.67 ms. This is the refresh cycle time for a 60 Hz refresh rate. Additional refresh frame time is required when text is added to the vector display. Many applications will require that some text also be written on the screen. Figure 3-32 summarizes the capabilities of the 1345A for various text and vector length combinations.

The data shown in the table, in figure 3-32, was generated using the equations in figure 3-33. To generate data for other writing speeds and character combinations, insert the appropriate values of the variables into the equations and calculate the time it takes to draw each portion of the picture.

Generating a complex picture requires knowledge of the number of vectors required. Two pictures will be used as examples that have quite different appearances. These two pictures are shown in figures 3-34 and 3-35. The methods used to generate these pictures will be discussed to give the user an idea of what is involved in generating such a picture.

Conditions.

Average character drawing time: 16 μsec
Recommended refresh rate: 60 Hz ~ 16.6 msec
1345A writing speed: 0.1 in./μsec
Vector dead time: 1 μsec

	NUMBER OF CHARACTERS TO BF DRAWN			
	0	100	200	300
Total frame time (msec)	16.67	16.67	16.67	16.67
Character writing time (msec)	0	1.60	3.20	4.80
Time left to draw vectors (msec)	16.67	15.07	13.47	11.87
AVERAGE VECTOR LENGTH	APPROXIMATE NUMBER OF VECTORS DRAWN			
0.1 in.	8330	7530	6730	5930
0.5 in.	2770	2510	2240	1970
2.0 in.	790	710	640	560
6.0 in.	270	240	220	190

Figure 3-32. 1345A Capabilities for Character and Vector Combinations

$$\text{VECTOR DRAWING TIME} = \frac{\text{VECTOR LENGTH}}{\text{WRITING SPEED}} + \frac{1\ \mu s}{\text{VECTOR}}$$

$$\text{PICTURE DRAWING TIME} = \sum_{1}^{N} \frac{\text{VECTOR LENGTH}}{\text{WRITING SPEED}} + \frac{1\ \mu s}{\text{VECTOR}} + \sum_{1}^{M} \frac{15\ \mu s}{\text{CHARACTER}}$$

N = TOTAL NUMBER OF VECTORS

M = TOTAL NUMBER OF CHARACTERS

Figure 3-33. Vector Drawing Time Calculations

The first picture, figure 3-34, is representative of a spectrum analyzer display. This picture contains 750 vectors per data trace and 265 characters. There are 22 vectors in the graticule and 1500+ in the data traces. By using the table in figure 3-32 the 1345A can display up to 1970 0.5 in. vectors at a writing speed of 0.1 in./μs. In these examples, the writing speed is set at 0.5in./μs. At that writing speed and an average of 0.1 in. per vector, the 1345A can draw up to 3956 vectors and up to 300 characters. This trace has 1500+ vectors and 265 characters. The 1345A could draw over twice as many vectors as shown in this example within the 16.67 ms refresh cycle time.

The second picture, figure 3-35, is representative of a "SMITH CHART" display. There are 528 vectors in the graticule and a total of 133 characters used for annotation. The graticule in this picture is more complex and requires more vectors. Notice that the vectors in this graticule are very short and give the appearance of a curve. There are 150 vectors in the trace. These are also very short vectors and give the appearance of a curve. The vectors were drawn at a writing speed of 0.5 in./μs. The 1345A can draw over 4400 0.1 in. vectors and 200 characters within a 16.67 ms refresh cycle time. In this display, there are a total of 678 vectors and 133 characters. The 1345A could draw over 7 times as many 0.1 in. vectors and up to 200 characters and still satisfy a 60 Hz refresh requirement.



Figure 3-34. A Spectrum Analyzer Presentation



Figure 3-35. A Smith Chart Presentation

In figure 3-36 there are two additional examples of 1345A instrumentation displays.

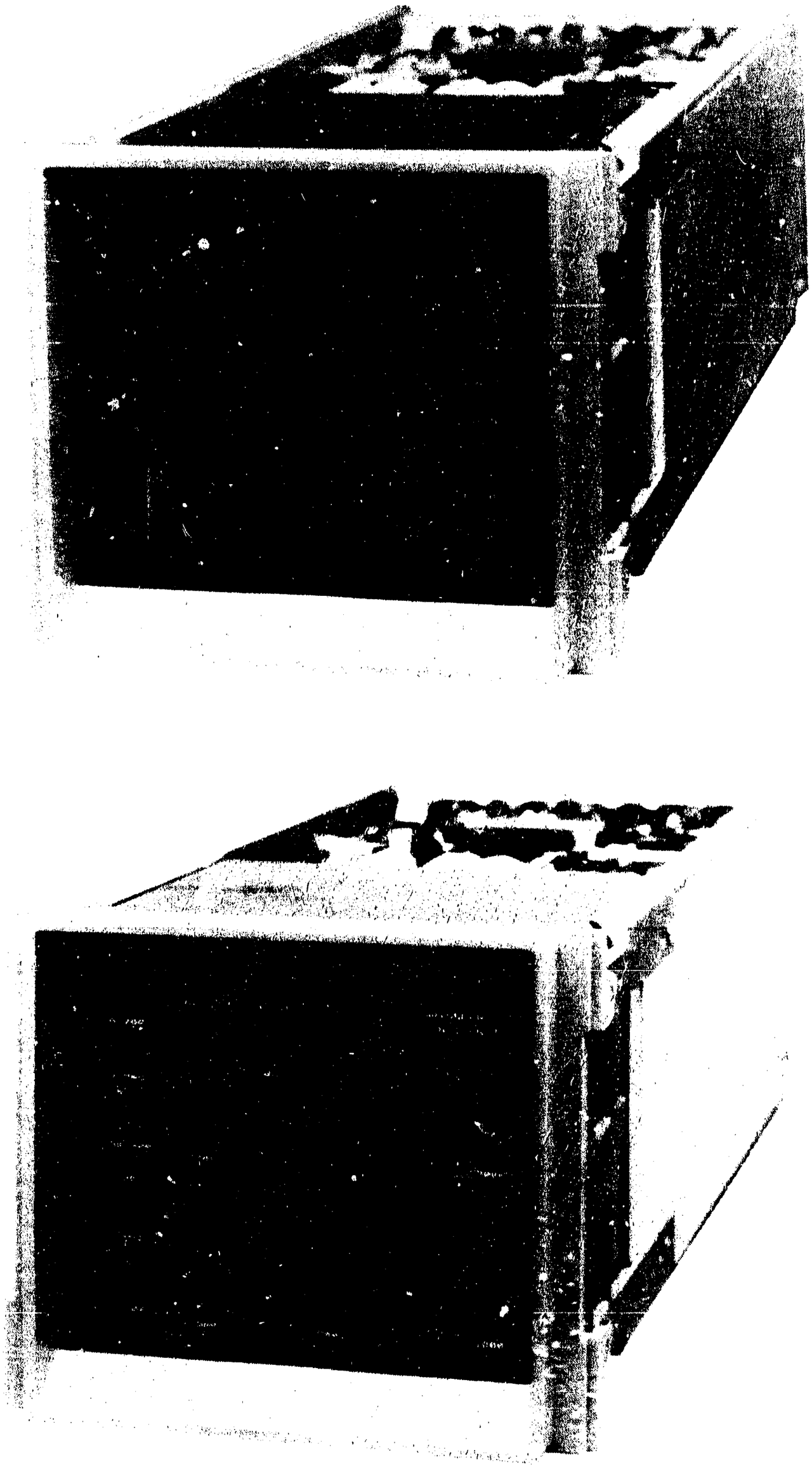
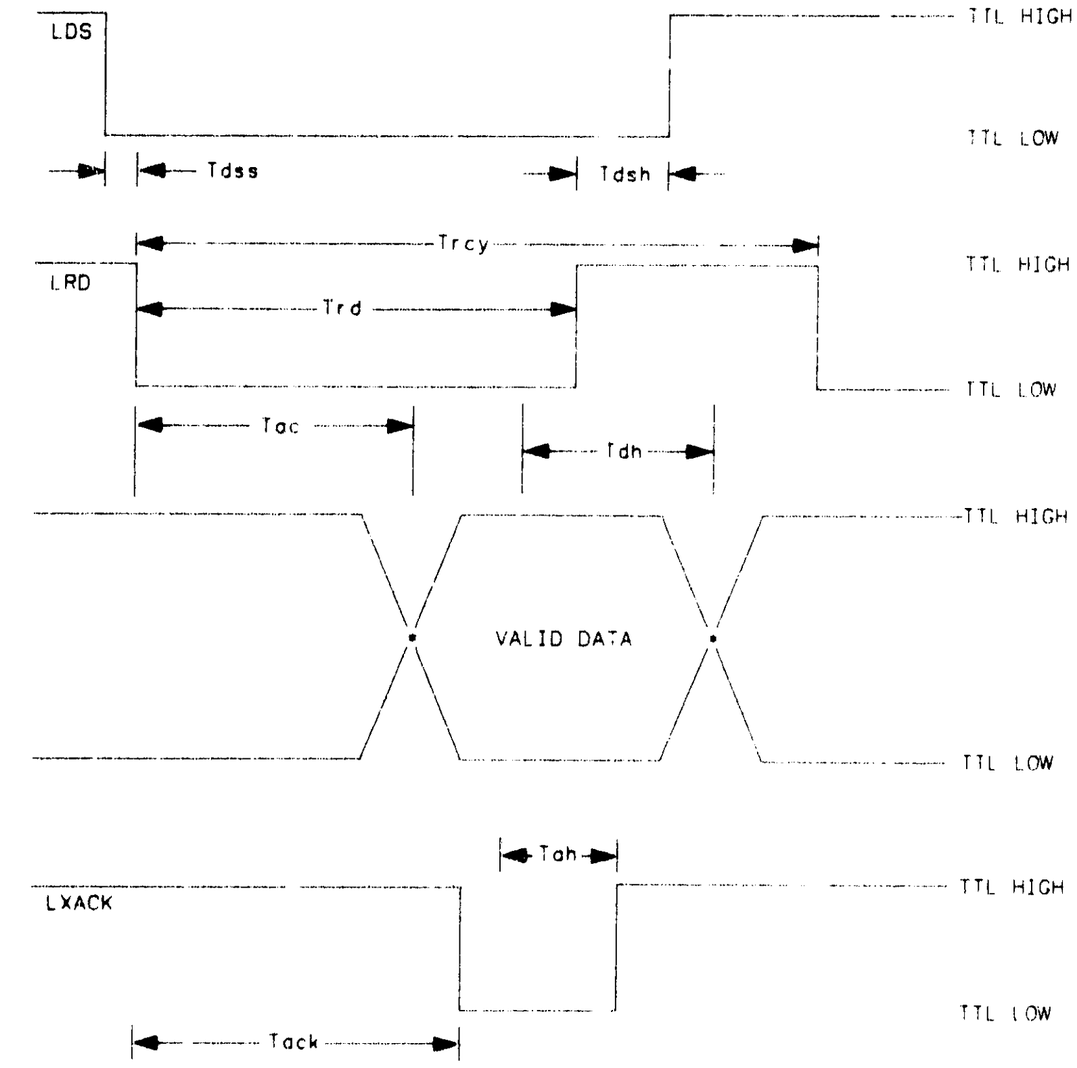


Figure 3-36. Additional 1345A Example Displays

3-24. VECTOR MEMORY READ AND WRITE SIGNAL TIMING SPECIFICATIONS.

READ COMMAND TIMING



M1349002

Tdss — Device Select Setup Time 0 nsec min
Tdsh — Device Select Hold Time 0 nsec min
Trcy — Read Cycle Time (ACK not used) 394 nsec min
(ACK used) 402 nsec min
Trd — Read Pulse Time (ACK not used) 319 nsec min
(ACK used) 327 nsec min
Tac — Read Access Time 319 nsec max
Tdh — Read Data Hold Time 11 nsec min
Tah — Acknowledge Hold Time 17 nsec min
82 nsec max
Tack — Acknowledge Delay Time 327 nsec min
459 nsec max

NOTE

Display refreshing is inhibited when LRD is low.

Figure 3-37. Read Con mand Timing

SAFETY SUMMARY

The following general safety precautions must be observed during all phases of operation, service, and repair of this instrument. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the instrument. Hewlett-Packard Company assumes no liability for the customer's failure to comply with these requirements.

GROUND THE INSTRUMENT.

To minimize shock hazard, the instrument chassis and cabinet must be connected to an electrical ground. The instrument is equipped with a three-conductor ac power cable. The power cable must either be plugged into an approved three-contact electrical outlet or used with a three-contact to two-contact adapter with the grounding wire (green) firmly connected to an electrical ground (safety ground) at the power outlet. The power jack and mating plug of the power cable meet International Electrotechnical Commission (IEC) safety standards.

DO NOT OPERATE IN AN EXPLOSIVE ATMOSPHERE.

Do not operate the instrument in the presence of flammable gases or fumes. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.

KEEP AWAY FROM LIVE CIRCUITS.

Operating personnel must not remove instrument covers. Component replacement and internal adjustments must be made by qualified maintenance personnel. Do not replace components with power cable connected. Under certain conditions, dangerous voltages may exist even with the power cable removed. To avoid injuries, always disconnect power and discharge circuits before touching them.

DO NOT SERVICE OR ADJUST ALONE.

Do not attempt internal service or adjustment unless another person, capable of rendering first aid and resuscitation, is present.

USE CAUTION WHEN EXPOSING OR HANDLING THE CRT.

Breakage of the Cathode-ray Tube (CRT) causes a high-velocity scattering of glass fragments (implosion). To prevent CRT implosion, avoid rough handling or jarring of the instrument. Handling of the CRT shall be done only by qualified maintenance personnel using approved safety mask and gloves.

DO NOT SUBSTITUTE PARTS OR MODIFY INSTRUMENT.

Because of the danger of introducing additional hazards, do not install substitute parts or perform any unauthorized modification of the instrument. Return the instrument to a Hewlett-Packard Sales and Service Office for service and repair to ensure that safety features are maintained.

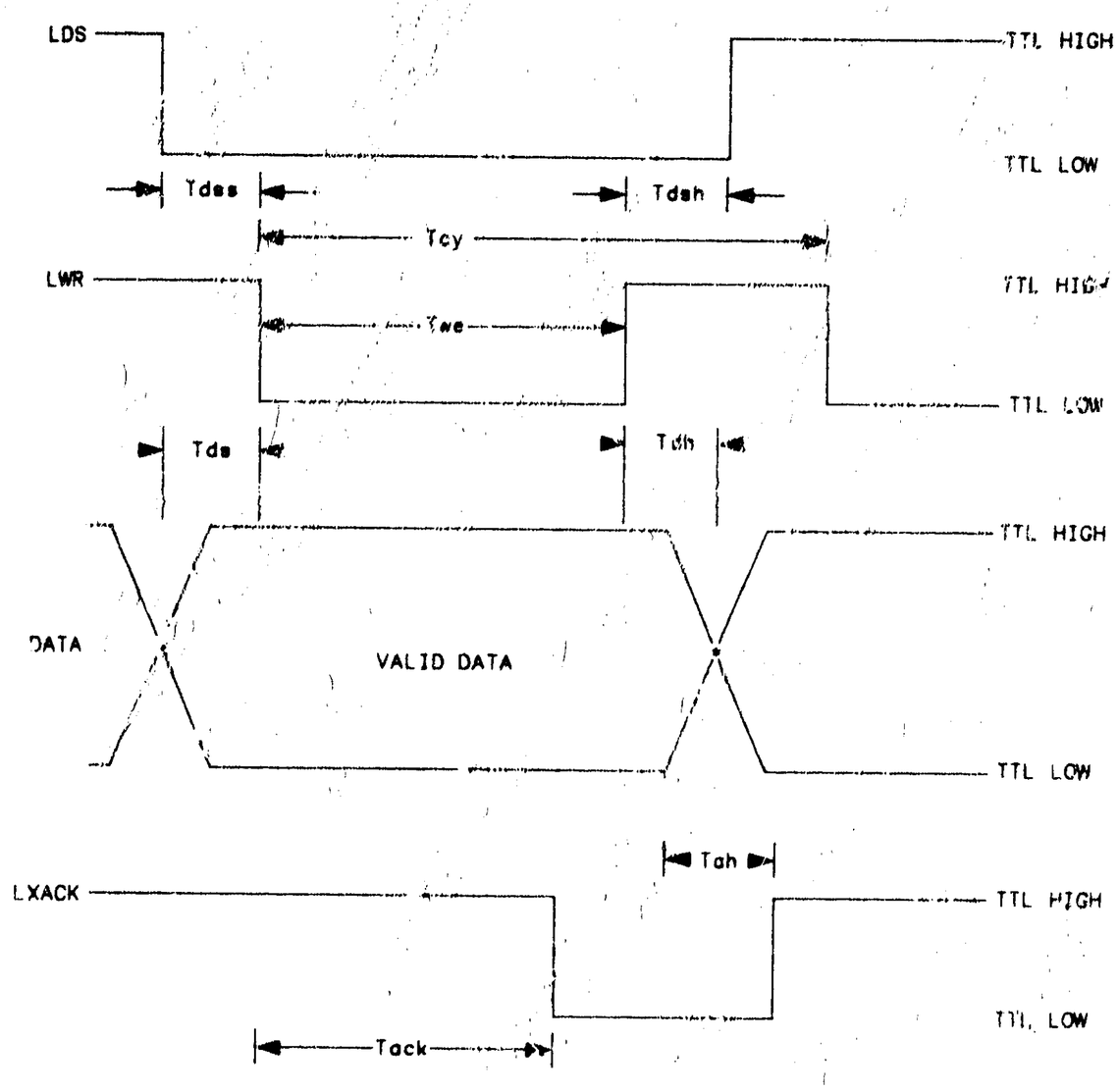
DANGEROUS PROCEDURE WARNINGS.

Warnings, such as the example below, precede potentially dangerous procedures throughout this manual. Instructions contained in the warnings must be followed.

WARNING

Dangerous voltages, capable of causing death, are present in this instrument. Use extreme caution when handling, testing, and adjusting.

WRITE COMMAND TIMING



Tdss — Device Select Setup Time 0 nsec min
Tdsh — Device Select Hold Time 0 nsec min
Tcy — Write Cycle Time 565 nsec min
Twe — Write Command Active Time .. 360 nsec min
Tds — Data In Setup Time 0 nsec max
Tdh — Data In Hold Time 50 nsec min
Tack — Acknowledge Delay Time 327 nsec min
459 nsec max
Tah — Acknowledge Hold Time 17 nsec min
82 nsec max

NOTE

Display refreshing is inhibited when LWR is low.

Figure 3-38. Write Command Timing

3-25. PROGRAMMING.

With Option 704 installed, all commands from the user processor go to Vector Memory. Figure 3-26 is a block diagram of this configuration. A Vector Memory Command is defined as a Read or Write operation initiated by the user processor.

1. WRITE OPERATION.

The Write Operation allows the 16 bits on the data bus to be written into either the Vector Memory or the Address Pointer. A Vector Memory Word can be either a Picture Data Word or an Internal Jump Word.

PICTURE DATA WORD. When bit M15 is set low, the other 15 data bits (M14-M0) must conform with the 1345A Commands covered earlier in this document under Data Bit Definitions for 1345A Commands.

MSB														LSB	
M15	M14	M13	M12	M11	M10	M9	M8	M7	M6	M5	M4	M3	M2	M1	M0
0	B14	B13	B12	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0

(SEE DATA BIT DEFINITIONS FOR 1345A COMMANDS.)

When the display is refreshed, this data is sent from the Vector Memory to the 1345A for vector and/or character generation. Display refresh is accomplished without attention from the user processor once the picture has been loaded into Vector Memory. The Write Operation is controlled by the handshake sequence as presented in figure 3-38.

INTERNAL JUMP WORD. When M15 is high and M14 is low, then data bits M11 through M0 designate the address of the next word in Vector Memory that will be sent to the 1345A. This allows the Vector Memory to skip blocks of picture data on each pass through its address range when it is refreshing the display. Certain data in Vector Memory is effectively suppressed until the user processor wants that data to be displayed. Refer to figure 3-39 for an example of using the Jump Instruction. When needed a suppressed block of data can be added to the picture by changing only the Vector Memory word that contains the internal jump code.

NOTE:

The address specified by an internal jump instruction cannot contain another internal jump instruction (as defined by M15 and M14). If this command sequence is attempted, a blank display will result until memory is re-accessed by the user processor.

An internal jump does not affect the Vector Memory address pointer.

MSB														LSB	
M15	M14	M13	M12	M11	M10	M9	M8	M7	M6	M5	M4	M3	M2	M1	M0
1	0	X	X	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0

X=DON'T CARE

M15=1, M14=0: Internal jump to vector address specified by A11 thru A0 during refresh.

POINTER INSTRUCTION. When bits M15 and M14 are both high, then data bits M11 Through M0 designate the address to which the Vector Memory Address Pointer will move. The value in the pointer register specifies the next address in Vector Memory that will be written into (or read from) by the processor.

The pointer increments to the next Vector Memory address after each read or write operation commanded by the user processor.

MSB														LSB	
M15	M14	M13	M12	M11	M10	M9	M8	M7	M6	M5	M4	M3	M2	M1	M0
1	1	X	X	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0

X=DON'T CARE

M15=1, M14=1: Set pointer register to the Vector Memory address value specified by A11 thru A0.

NOTE

The pointer value is placed in the Vector Memory pointer register, NOT in the Vector Memory.

2. READ OPERATION.

The Address Pointer value specifies the word to be read from Vector Memory. The Pointer increments with each Write or Read operation to the Vector Memory. Positioning of the Address Pointer can also be accomplished via a write operation. This allows a selected word to be read from Vector Memory. The Read operation is controlled by the Handshake sequence as presented in figure 3-37.

3. PROGRAMMING SUMMARY.

A programming summary for the 1345A commands and Option 704 instruction is given in table 3-2.

Table 3-2. Truth Table for 1345A Commands and Option 704 Instructions

BIT NUMBER M15	M14	M13	1345A COMMAND/OPTION 704 INSTRUCTION
0	0	0	PLOT
0	0	1	GRAPH
0	1	0	TEXT
0	1	1	SET CONDITION
1	0	0	INTERNAL JUMP
1	0	1	INTERNAL JUMP
1	1	0	SET POINTER
1	1	1	SET POINTER

3-28. POTPOURRI

a. Memory Initialization.

When the Vector Memory is powered up, its contents are in an unknown random state. There are several methods of memory initialization.

Since the preferred way for the Vector Memory to enter the synchronous refresh mode is when a "jump to 4095" is executed, the user may want to fill the entire Vector Memory with "jump to 4095" instructions upon initialization.

One benefit of using this method of initialization is that as the user fills the Vector Memory with picture information, the Vector Memory will always "jump to 4095" after drawing the picture, no matter how many words are used to form the picture. This ensures that the picture will be displayed at the optimum refresh rate.

Another way of initializing the Vector Memory is to write all zeros to all words. This data will be sent to the 1345A, but will draw nothing on screen (effectively a no-op). The drawback to this method is that without a "jump to 4095", each "no-op" will take about one microsecond. Depending on the picture information subsequently stored in memory, these no-op instructions may result in a dimmer picture (non-optimized refresh rate).

The Vector Memory can be tested by the user processor as part of power-on self test routine. For example, first write all zeros to all words. Then "chase a one" through memory to check each cell. Also, the Vector Memory pointer register can be checked by writing data sequentially through the memory and then using the Pointer Instruction to move the pointer and reading the contents of the word selected by the pointer. BE CAREFUL - 11XXXXXXXXXXXXXX will not be written into the memory and 011XXXXXX1XXXXXX is illegal.

b. Using the Jump Instruction.

The Internal Jump instruction resides in the Vector Memory. When it is encountered in the course of refreshing the 1345A it is not sent to the 1345A. Instead, it causes the Vector Memory to do an absolute jump to a new location. The Vector Memory then resumes sending data to the 1345A.

This allows the user to store pictures in the Vector Memory but not display them until ready (by jumping past them). See figure 3-39.

By putting jump instructions around each block of data, it allows the user to turn parts of the complete picture on or off by writing only one or two words to the Vector Memory.

Picture A might be used as a standard to compare against picture B which is being updated. For this application, picture A can be turned on whenever it is needed by changing the contents of address 0000 to be "Jump to 0001".

NOTE

Vector Memory location 4095 is the first location sent to the 1345A in each refresh cycle. The Vector Memory then auto-increments to location 0000, 0001, etc.

VECTOR MEMORY

Address	Contents
0000	JUMP TO 1002
0001 to 1000	PICTURE A
1001	JUMP TO 1002
1002 to 2002	PICTURE B
2003	JUMP TO 2062
2004 to 2060	GRATICULE A
2061	JUMP TO 2062
2062 to 2147	GRATICULE B
2148	JUMP TO 4095
2149 to 2255	SET OF LABELS
2256	JUMP TO 4095
2257 to 4094	UNUSED MEMORY
4095	NO-OP (REQUIRED)

Figure 3-39.

1345A Quick Reference Guide

1345A COMMANDS.

NOTE: Bit D15 is used only for vector memory board commands. For standard 1345A commands, D15 should be 0.

1345A 16 Bit Data Word.

MSB LSB

D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
COMMAND	←	COMMAND MODIFIERS													→

1345A COMMANDS

	Bit 14	Bit 13
Set Condition	1	1
Plot Command	0	0
Graph Command	0	1
Text Command	1	0

Set Condition Command.

Set Condition Command:

MSB LSB

D15	D14	D13	D12	D11	D10	D9	D8	D7	D6*	D5	D4	D3	D2	D1	D0
0	1	1	I_1	I_0	X	L_2	L_1	L_0	0	X	W_1	W_0	X	X	X

*Note: Bit 6 (D6) must be zero.

Command Modifiers:

a. To Set Line Intensity:

I_1	I_0	Intensity
0	0	Blank
0	1	Dim
1	0	Half Brightness
1	1	Full Brightness

b. To Set Line Type:

L_2	L_1	L_0	Type
0	0	0	Solid Line
0	0	1	Intensified End Points on Solid Line
0	1	0	Long Dashes
0	1	1	Short Dashes
1	0	1	Dots on Endpoints

c. To Set Writing Speed:

W_1	W_0	Speed
1	1	0.05 in. per μs
1	0	0.10 in. per μs
0	1	0.15 in. per μs
0	0	0.20 in. per μs

Plot Command:

Plot Command:

MSB LSB

D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
0	0	0	XY	PC	D_{10}	D_9	D_8	D_7	D_6	D_5	D_4	D_3	D_2	D_1	D_0
					←	DATA									→

Command Modifiers:

a. XY Information (D12)

0 = X coordinate (0-2047), specified by D_0-D_{10}
1 = Y coordinate (0-2047), specified by D_0-D_{10}

b. PC Beam Control Information (D11)

0 = Beam OFF (move)
1 = Beam ON (draw)

Programming Command Ranges

PROGRAMMING COMMAND RANGES OF THE 1345A

1345A Command	Octal Range	Hexadecimal Range
a. Plot		
X	00000-07777	0000-0FFF
Y (beam off)	10000-13777	1000-17FF
Y (beam on)	14000-17777	1800-1FFF
b. Graph		
Set Delta-X	20000-27777	2000-2FFF
Y (beam off)	30000-33777	3000-37FF
Y (beam on)	34000-37777	3800-3FFF
c. Text	40000-57777	4000-5FFF
d. Set Condition	60000-77777	6000-7FFF

Graph Command

Graph Command:

MSB LSB

D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
0	0	1	XY	PC	D_{10}	D_9	D_8	D_7	D_6	D_5	D_4	D_3	D_2	D_1	D_0
					←	DATA									→

Command Modifiers:

a. XY Information (D12)

0 = Set Delta-X increment, specified by D_0-D_{10} for all subsequent Y coordinates
1 = Set Y coordinate, specified by D_0-D_{10}. The beam is to be moved to this Y in conjunction with the Delta X increment.

b. PC Beam Control Information (D11)

0 = Beam OFF (move)
1 = Beam ON (draw)

MEMORY BOARD COMMANDS.

Vector Memory Word.

M15	M14	M13	M12	M11	M10	M9	M8	M7	M6	M5	M4	M3	M2	M1	M0
0	B_{14}	B_{13}	B_{12}	B_{11}	B_{10}	B_9	B_8	B_7	B_6	B_5	B_4	B_3	B_2	B_1	B_0

(SEE DATA BIT DEFINITIONS FOR 1345A COMMANDS)

Internal Jump.

An internal jump does not affect the Vector Memory address pointer.

M15	M14	M13	M12	M11	M10	M9	M8	M7	M6	M5	M4	M3	M2	M1	M0
1	0	X	X	A_{11}	A_{10}	A_9	A_8	A_7	A_6	A_5	A_4	A_3	A_2	A_1	A_0

X = DON'T CARE
M15 = 1, M14 = 0: Internal jump to Vector Memory address specified by A_{11} thru A_0 during refresh.

Address Pointer.

M15	M14	M13	M12	M11	M10	M9	M8	M7	M6	M5	M4	M3	M2	M1	M0
1	1	X	X	A_{11}	A_{10}	A_9	A_8	A_7	A_6	A_5	A_4	A_3	A_2	A_1	A_0

X = DON'T CARE
Set pointer register to the Vector Memory address value specified by A_{11} thru A_0.

1345A Modified ASCII Character Set.

1345A MODIFIED ASCII CODE CONVERSION TABLE

LEAST SIGNIFICANT CHARACTER	MOST SIGNIFICANT CHARACTER 0	1	2	3	4	5	6	7
0		centered*	SP	0	@	P	`	p
1	HP logo	centered	!	1	A	Q	a	q
2	β	:	"	2	B	R	b	r
3		—	#	3	C	S	c	s
4	upper-half tic	↓	$	4	D	T	d	t
5	lower-half tic	→	%	5	E	U	e	u
6	left-half tic	√	&	6	F	V	f	v
7	right-half tic	π	'	7	G	W	g	w
8	back space	Δ	(	8	H	X	h	x
9	1/2 shift down	μ	)	9	I	Y	i	y
A	line feed	°(degree)	*	:	J	Z	j	z
B	inv. line feed	Ω	+	;	K	[	k	{
C	1/2 shift up	ρ	,	<	L	\	l	¦
D	carriage return	Γ	-	=	M	]	m	}
E	horizontal tic	θ	.	>	N	^	n	~
F	vertical tic	λ	/	?	O	—	o	▶

EXAMPLES:

HP logo	=	01
A	=	41
i	=	69
√	=	16
▶	=	7F
line feed	=	0A

Text Command.

Text Command:

MSB															LSB
D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
0	1	0	S_1	S_0	R_1	R_0	ES	C_7	C_6	C_5	C_4	C_3	C_2	C_1	C_0
								CHARACTER →							

Command Modifiers:

For C_0-C_7, see modified ASCII conversion table

a. ES Establish Size of Character

0 = Use previous size and rotation
1 = Establish new size and rotation according to S_1,S_0, R_1 and R_0

b. Rotate Character CCW

R_1	R_0	Rotation
0	0	0 degrees
0	1	90 degrees
1	0	180 degrees
1	1	270 degrees

S_1	S_0	Size	W × H (in addressable points)
0	0	1×	24 × 36
0	1	1.5×	36 × 54
1	0	2×	48 × 72
1	1	2.5×	60 × 90

4 PROGRAMMABLE CHARACTER SIZES:

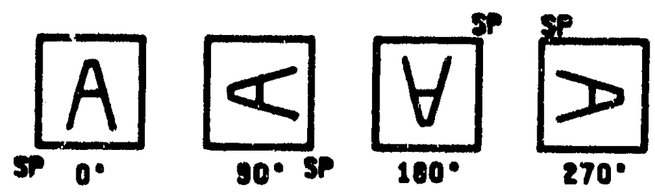
1.0 × 56 characters per line, 28 horizontal lines possible.

1.5 × 37 characters per line, 18 horizontal lines possible.

2.0 × 28 characters per line, 14 horizontal lines possible.

2.5 × 22 characters per line, 11 horizontal lines possible.

Character Rotation.



Capabilities for Character and Vector Combinations.

Conditions.

Average character drawing time: 16 μsec
Recommended refresh rate: 60 Hz ~ 16.6 msec
1345A writing speed: 0.1 in./μsec
Vector dead time: 1 μsec

	Number of Characters to be Drawn			
	0	100	200	300
Total frame time (msec)	16.67	16.67	16.67	16.67
Character writing time (msec)	0	1.60	3.20	4.80
Time left to draw vectors (msec)	16.67	15.07	13.47	11.87
AVERAGE VECTOR LENGTH	Approximate Number of Vectors Drawn			
0.1 in.	8330	7530	6730	5930
0.5 in.	2770	2510	2240	1970
2.0 in.	790	710	640	560
6.0 in.	270	240	220	190

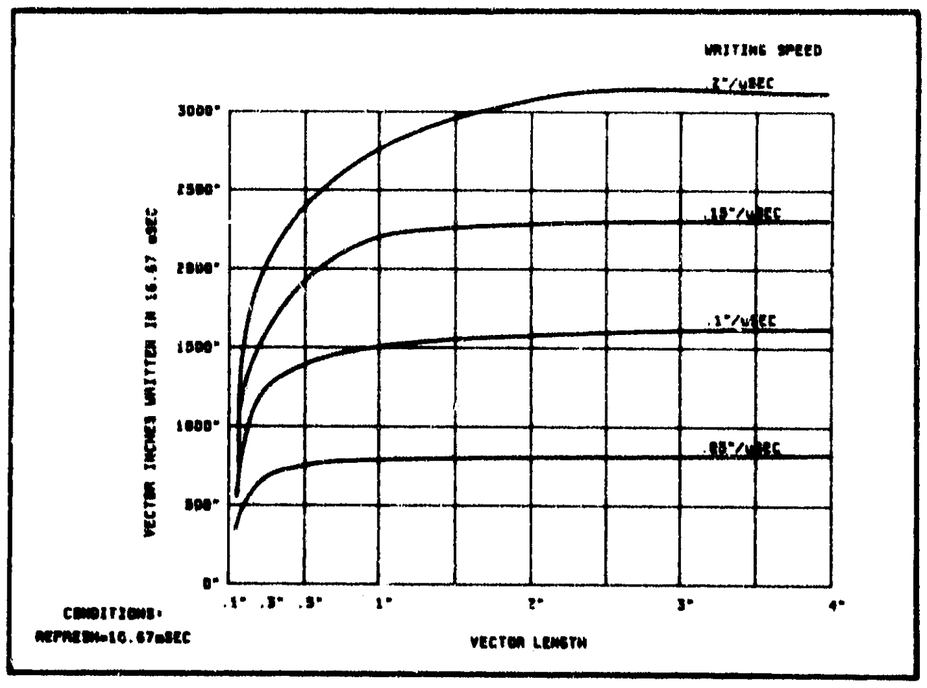
Vector Drawing Time Calculations.

$$\text{Vector Drawing Time} = \frac{\text{Vector Length}}{\text{Writing Speed}} + \frac{1\ \mu s}{\text{Vector}}$$

$$\text{Picture Drawing Time} = \sum_{1}^{N} \frac{\text{Vector Length}}{\text{Writing Speed}} + \frac{1\ \mu s}{\text{Vector}} + \sum_{1}^{M} \frac{15\ \mu s}{\text{Character}}$$

N = TOTAL NUMBER OF VECTORS
M = TOTAL NUMBER OF CHARACTERS

Vector Length vs. Writing Speed for 60 Hz Refresh Rate.



SECTION IV

PERFORMANCE CHECKS

4-1. INTRODUCTION.

4-2. The procedures in this section describe an abbreviated test that provides approximately 90% assurance of proper 1345A operation.

4-3. EQUIPMENT REQUIRED.

4-4. Equipment required for the performance tests is listed in Section 1, table 1-5. The performance verification program is internal to the 1345A. This routine is self activating and requires no additional equipment.

4-5. CALIBRATION CYCLE.

4-6. Periodic performance verification is not normally required for this instrument. Performance tests should be performed after service work has been performed or if improper operation is suspected.

4-7. Further checks that require access to the interior of the instrument are included in the adjustment section, but are not required for the performance verification.

WARNING

ELECTRICAL SHOCK HAZARD

This instrument is designed and manufactured for OEM systems. Protective covers are not provided and internal hazardous voltages are exposed when power is applied. Component replacement, including fuses, and internal adjustments must be made by qualified maintenance personnel.

4-8. PERFORMANCE TEST PROCEDURES.

PERFORMANCE TESTS

4-9. PERFORMANCE VERIFICATION.

DESCRIPTION:

The following procedure is directed at obtaining the correct performance vertification pattern on the 1345A screen. The internal test and calibration pattern may be initiated by pulling disconnect sense high from the user interface and tri-stating all other signal lines. The test pattern is used to verify correct operation of the 1345A without the use of an external controller by disconnecting the rear panel data cable and applying power to the 1345A. If the 1345A is functioning properly, the test and calibration pattern should appear on the display. Figure 4-2 shows a valid test and calibration pattern. The internal self test will also test the memory option if installed. If the memory is defective the 1345A will appear as in figure 4-5. If the 1345A is not calibrated or is not operating correctly, contact your local Hewlett-Packard authorized sales and service office.

EQUIPMENT REQUIRED:

Power Supply
Power Connector (Option 325)

PROCEDURE:

a. Adjust power supply outputs to values shown in table 4-1.

Table 4-1. Power Supply Output

Operating Voltages		Max P-P Ripple	Max Current	
Voltage	Tolerance		Standard	Option 704
+15 VDC	±5%	10 mV	1.05 A	1.05 A
-15 VDC	±5%	10 mV	0.3 A	0.3 A
+ 5 VDC	+5 -0%	50 mV	0.75 A	1.8 A

PERFORMANCE TESTS

b. Connect power supply to the 1345A and turn on power. (See figure 4-1 for power connections.)

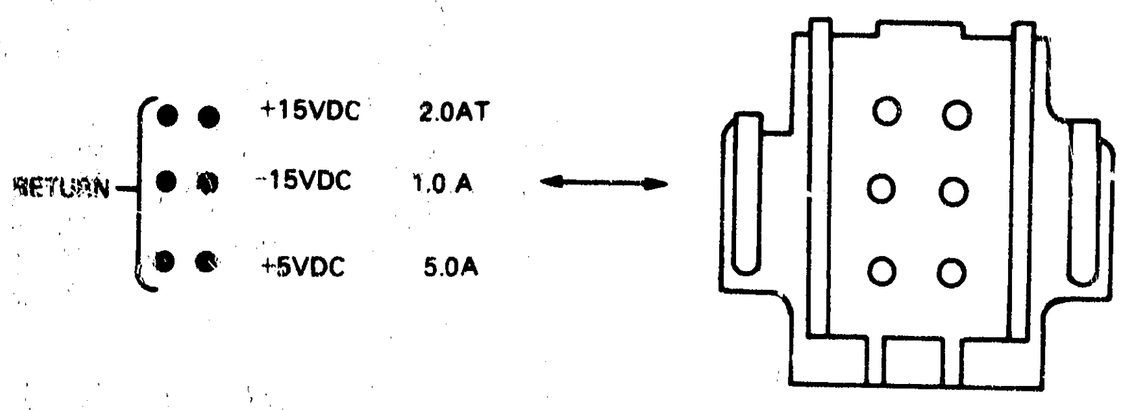


Figure 4-1. Rear Panel Power Connections

c. Check for a display as shown in figure 4-2.

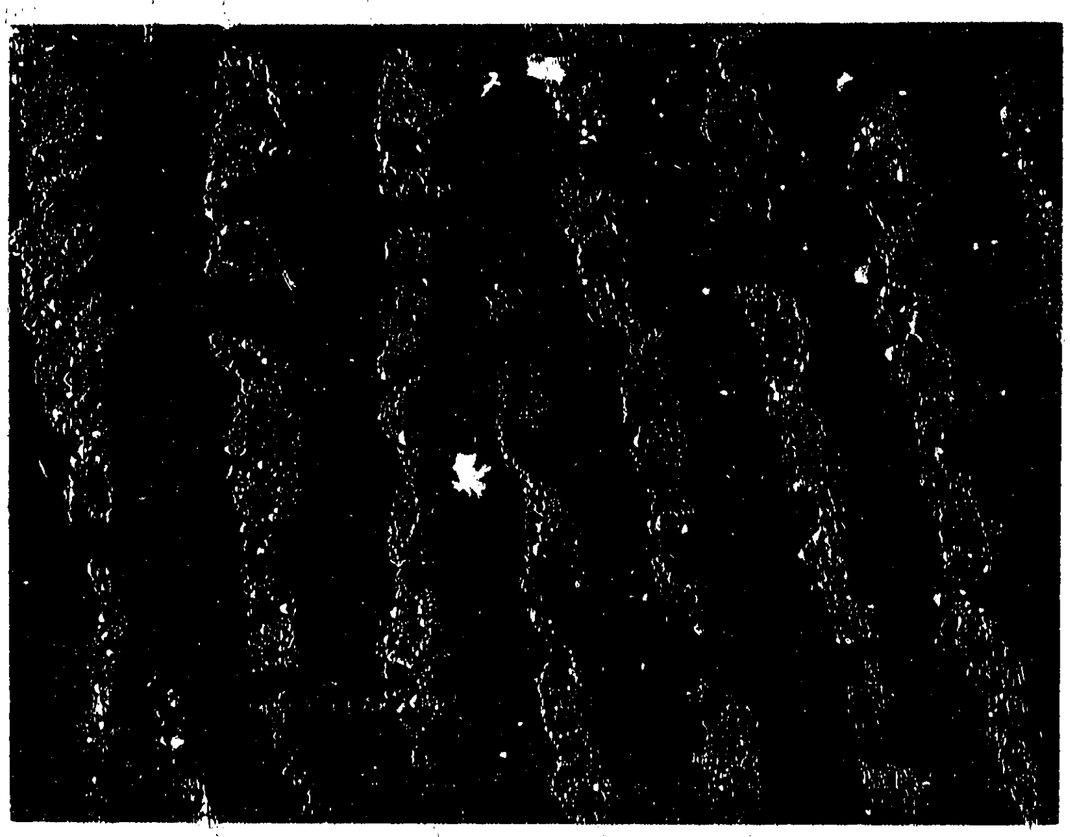


Figure 4-2. Display of Properly Calibrated Pattern

d. If display on screen appears as shown in figure 4-3, refer to Section 5, Adjustments.



Figure 4-3. Display of an Uncalibrated Verification Pattern

PERFORMANCE TESTS

e. The 1345A cycles through the four Commands: Set Condition, Plot, Graph, and Text Command. The relationship of the test pattern and the 1345A Commands is shown in figure 4-4. If any portion of the test pattern is not displayed, refer to Section VIII, Service and Troubleshooting.

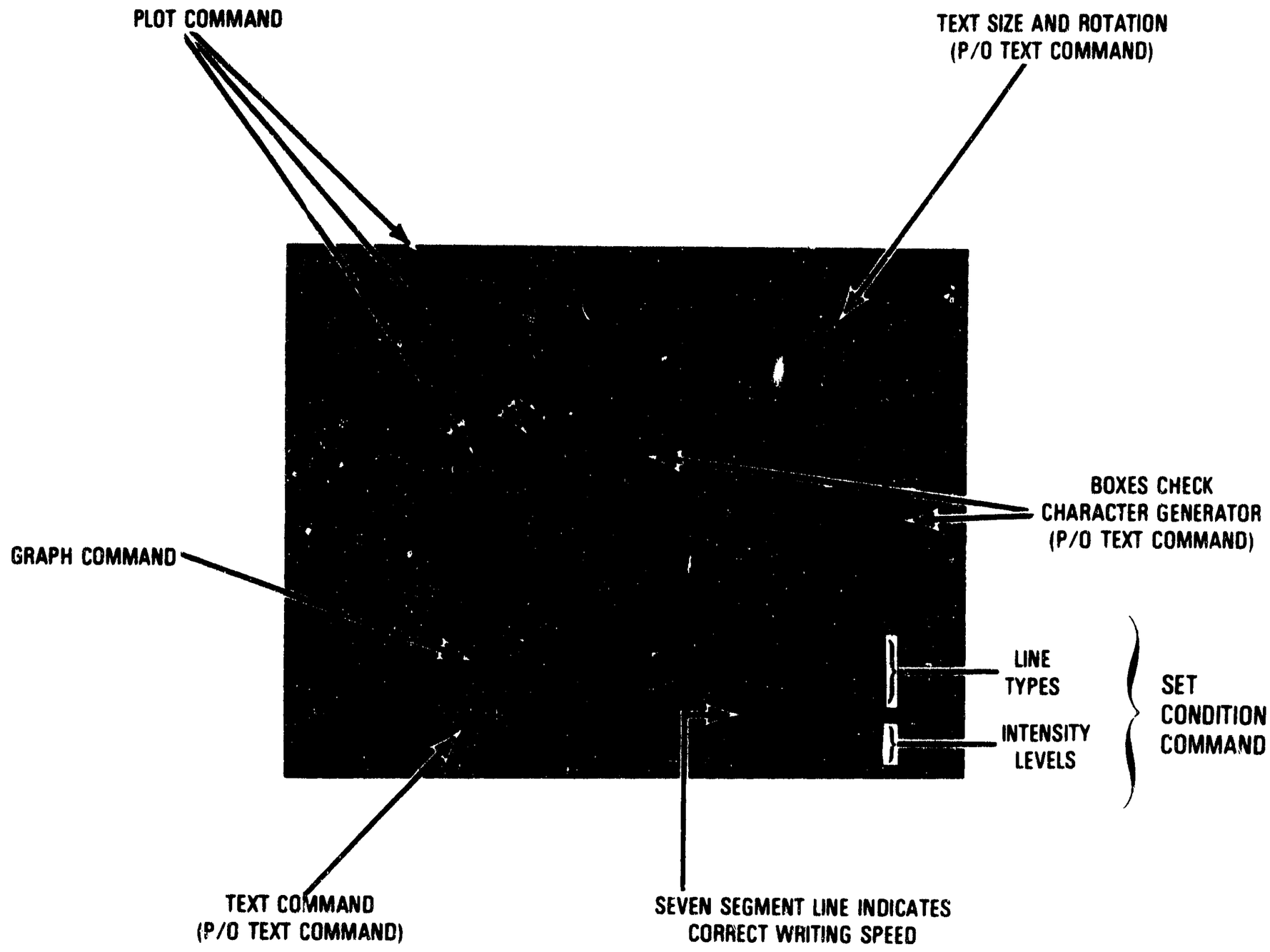


Figure 4-4. 1345A Command Check-out

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PERFORMANCE TESTS

f. If Option 704 is installed, the performance test will verify correct operation automatically. If the memory circuit is defective the display shown in figure 4-5 will appear.

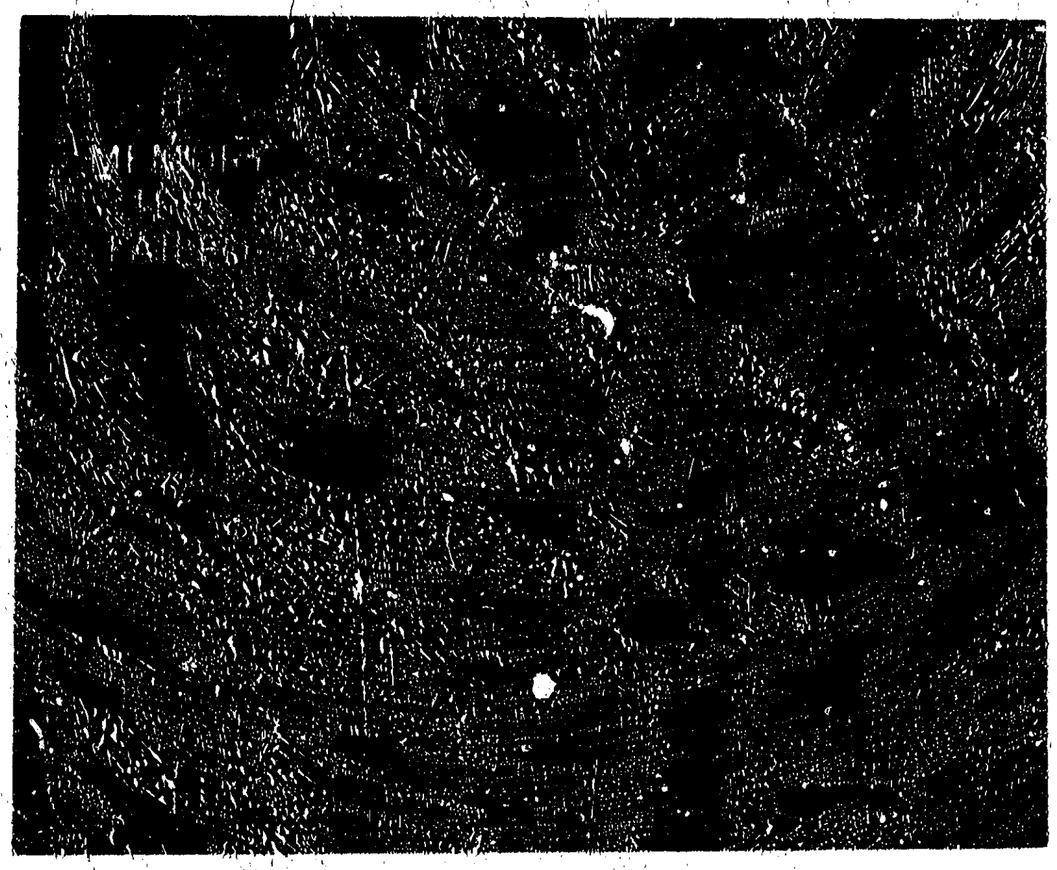


Figure 4-5. Memory Test Fail

g. If Memory Test fails, refer to Section 8, Service and Troubleshooting.

SECTION V

ADJUSTMENTS

5-1. INTRODUCTION.

5-2. This section describes adjustments and checks required to return the 1345A to peak operating capabilities when repairs have been made. Included in this section are equipment setups and adjustment procedures.

5-3. SAFETY REQUIREMENTS.

5-4. Although this instrument has been designed in accordance with international safety standards, general safety precautions must be observed during all phases of operation, service and repair of the instrument. Failure to comply with the precautions listed in the Safety Summary at the front of this manual or with specific warnings given throughout this manual could result in serious injury or death. Service and adjustments should be performed only by qualified service personnel.

5-5. EQUIPMENT REQUIRED.

5-6. A complete list of required test equipment is given in Section 1 table 1-5. Test equipment equivalent to that recommended may be substituted, provided it meets the required characteristics. For best results, use recently calibrated test equipment.

5-7. ADJUSTMENTS

5-8. The adjustment procedures are arranged in a recommended sequence of adjustments. While most adjustments may be made independent of other adjustments, it is recommended that adjustments be made sequentially as a number of adjustments are directly related to preceding or following adjustments.

5-9. Allow the instrument to warm up for 15 minutes before making adjustments. Adjustment locations for the 105V supply and the high voltage supply are shown in figures 5-2 and 5-3. Adjustment locations for pattern, stroke generator, and stroke intensity and focus adjustments are shown in figures 5-5, 5-8, and 5-11.

5-10. ADJUSTMENT PROCEDURES.

WARNING

ELECTRICAL SHOCK HAZARD

This instrument is designed and manufactured for OEM systems. Protective covers are not provided and internal hazardous voltages are exposed when power is applied. Voltages up to 2.4 kV are present around the CRT and HVPS areas and are capable of causing serious injury or death. Component replacement, including fuses, and internal adjustments must be made by qualified maintenance personnel.

Table 5-1. Sequence of Adjustments

Adjustment	Order of Adjustment	Paragraph No.
Low Voltage Power Supply	1	5-11
High Voltage Power Supply	2	5-12
Pattern	3	5-13
Stroke Generator	4	5-14
Stroke Intensity	5	5-15
Focus and Resolution	6	5-16
Writing Rate	7	5-17
Astigmatism and Pattern	8	5-18
Auxiliary X-Y-Z Output	9	5-19

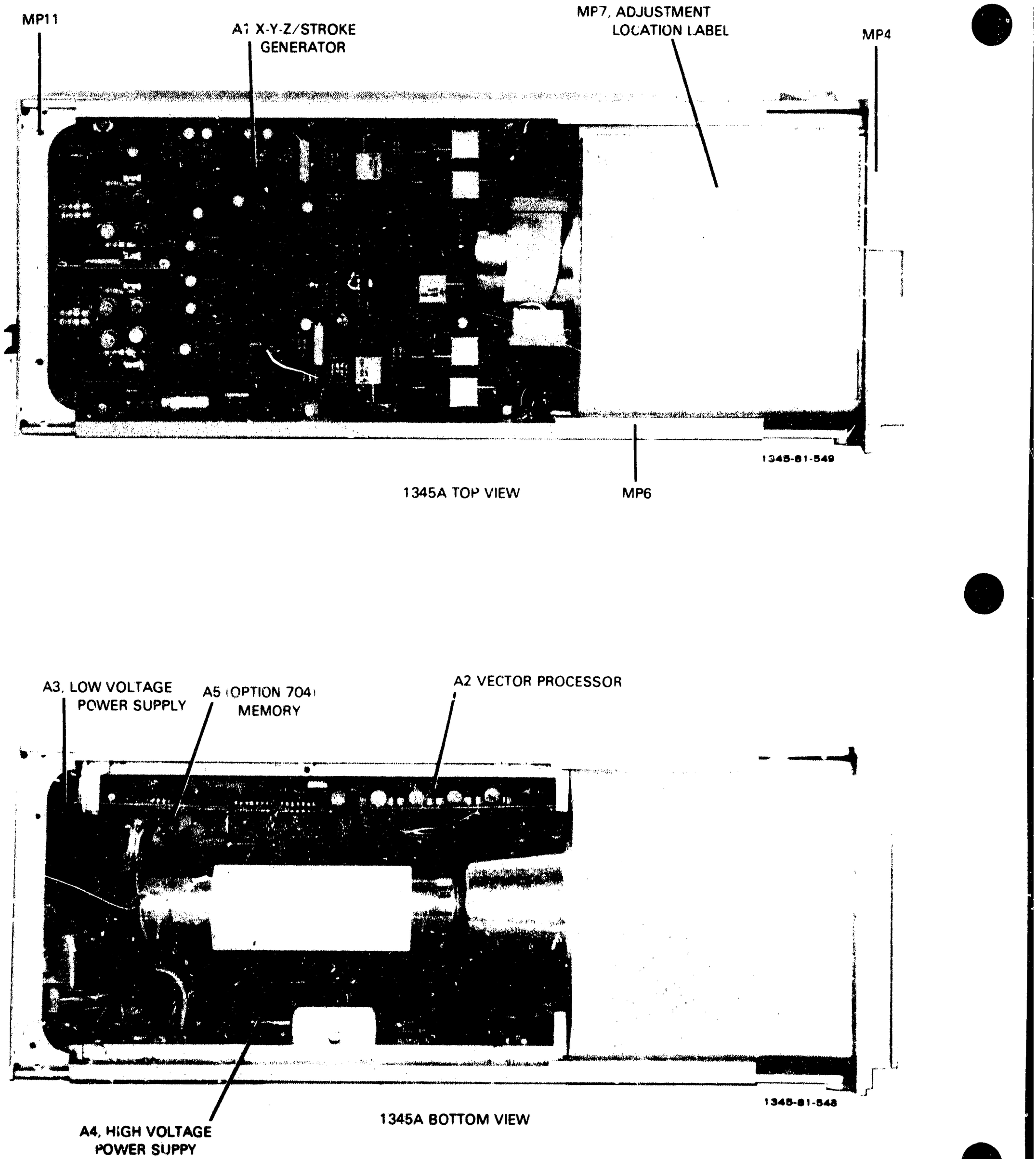


Figure 5-1. 1345A Assembly Location Identification

ADJUSTMENTS

5-11. Low Voltage Power Supply Adjustments.

Reference:
Service Sheet 4

Description.
In this procedure the input power supplies are verified and the 105 V power supply is adjusted to 105 V ±250 mV.

Equipment Required:
Digital Voltmeter
Power Supply
Power Connector (Option 325)

Procedure:
a. If connected, disconnect power plugs to the Stroke Generator Board (A1J8), Vector Processor Board (A2J5), and High Voltage Power Supply Board (A4J1) (see figure 5-2).

b. Apply power to the rear panel power connector and check input power supplies as indicated below:

MONITOR	SUPPLY	TEST LIMITS
A3TP1	+15 V	± 750 mV
A3TP2	-15 V	± 750 mV
A3TP3	+ 5 V	+ 250 mV -0 mV

c. Monitor A3TP4 and adjust the +105V (A3R10) Power Supply for 105 V ±250 mV. Turn off power supply and reconnect power cable to the Stroke Generator Board (A1J8).

d. Turn on power and monitor internally regulated power supplies as indicated below:

MONITIOR	SUPPLY	TEST LIMITS
A1J9 PIN 3	+15 V	±750 mV
A1VR4	+10 V	±500 mV
A1U33 PIN 2	+ 7 V	±350 mV
A1VR5	-3.1V	±150 mV
A1U30 PIN 3	- 8 V	±400 mV
A1J9 PIN 1	-15 V	±750 mV

e. Turn off power supply and reconnect power cable to Vector Processor Board (A2J5). Turn on power and monitor internally regulated power supplies as indicated below:

MONITOR	SUPPLY	TEST LIMITS
A2U15 PIN 34	+7 V	±350 mV
A2U19 PIN 16	+5 V	±250 mV
A2U15 PIN 14	+5 V	±250 mV
A2U15 PIN	-2 V	±100 mV

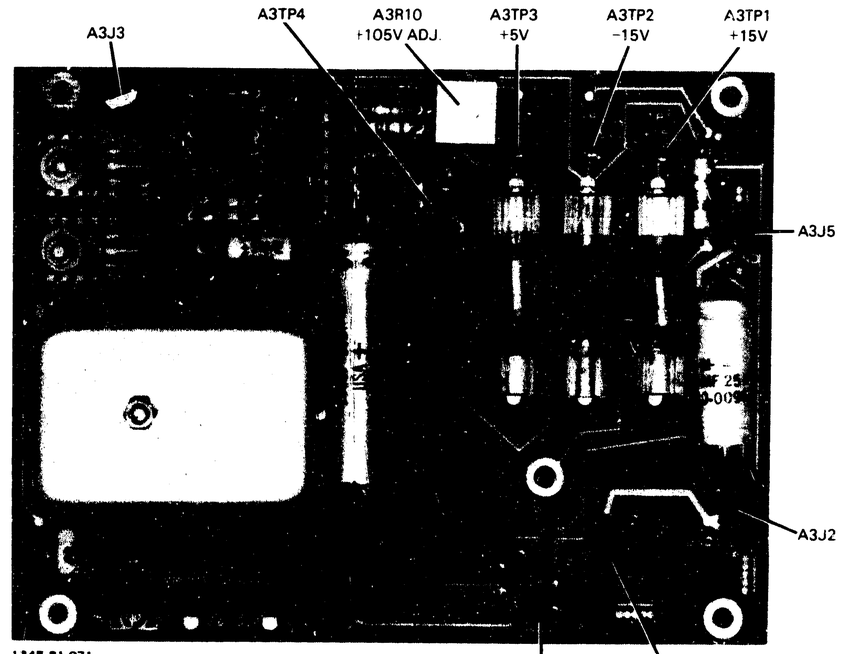


Figure 5-2. Low Voltage Power Supply Adjustment Locations

Table 5-2. +105 V Adjustment

Reference Designator	Adjustment Name	Adjustment Paragraph	Service Sheet	Description
A3R10	+105 V ADJUST	5-11,c	4	Adjust for +105 V ±250 mV

ADJUSTMENTS

5-12. HIGH VOLTAGE POWER SUPPLY ADJUSTMENT.

Reference:
Service Sheet 5.

Description:
This procedure describes the Cathode Voltage adjustment. The Cathode Voltage is set to -2350 V, ±100 V.

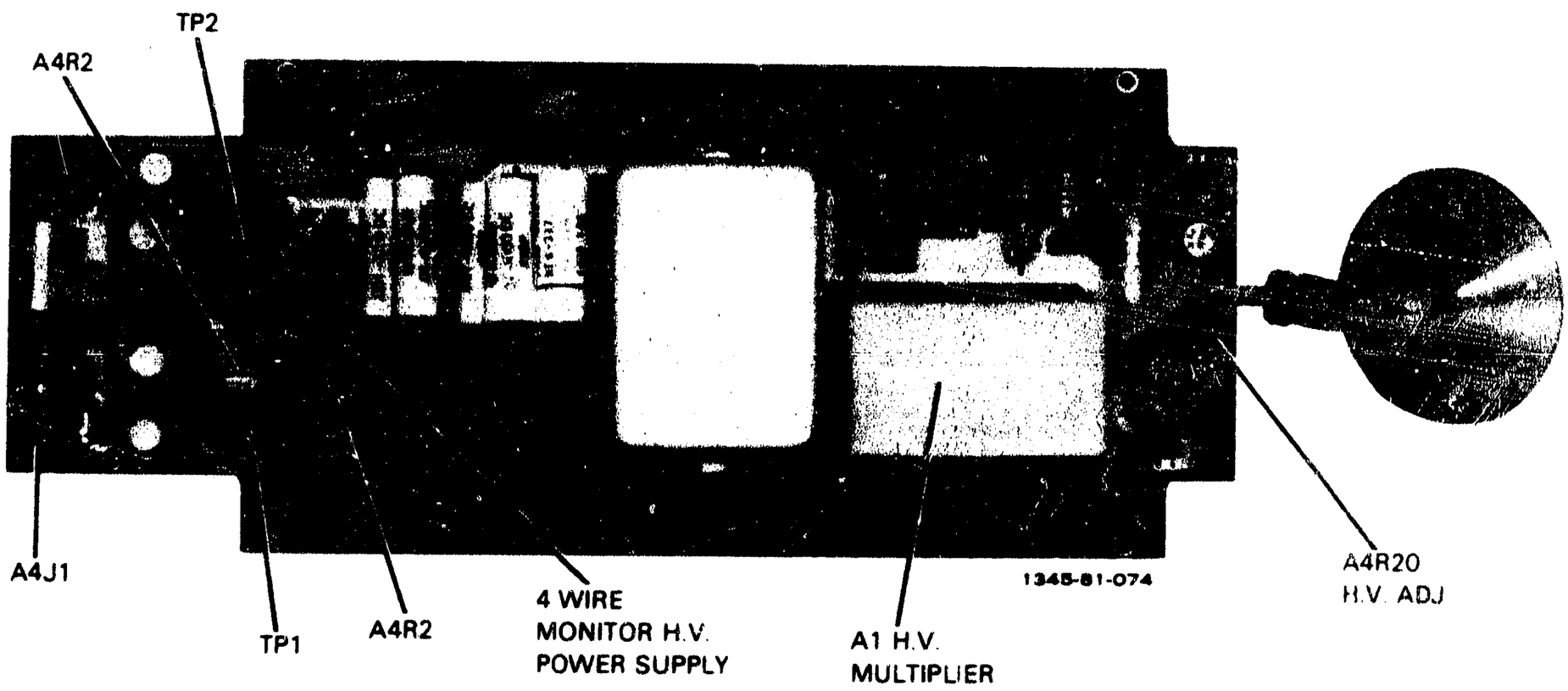
Equipment Required:
Digital Voltmeter
1000:1 Divider Probe
Power Supply
Power Connector (Option 325)

Procedure:

a. Adjust Intensity Cut-off Level (A1R131) and Intensity control (A1R129) to the CCW stop.

b. Connect power cable to High Voltage Power Supply Board (A4J1) and turn on power.

c. Monitor the cathode voltage (yellow wire on A4) using the 1000:1 divider probe and adjust High Voltage Adjust (A4R20) for -2350 V, ±100 V.



NOTE: THE HIGH VOLTAGE POWER SUPPLY CAN BE MONITORED ON THE CIRCUIT SIDE OF THE BOARD. PROBE AT THE TRACE MARKED -2450V.

Figure 5-3. High Voltage Power Supply Adjustment Locations

Table 5-3. High Voltage Adjust

Reference Designator	Adjustment Name	Adjustment Paragraph	Service Sheet	Description
A4R20	HIGH VOLTAGE ADJUST	5-12,c	5	Adjust for -2350 V ±100 V

ADJUSTMENTS

5-13. PATTERN ADJUSTMENT.

Reference:
Service Sheet 3C.

Description:
This procedure describes the adjustments necessary to obtain the internal pattern on the screen.

Equipment Required:
Power Supply
Power Connector (Option 325)

Procedure:
a. Apply power to the rear panel power connector and adjust Intensity Cut-off Level (A1R131) and Intensity Control (A1R129) until bright dots in the pattern are just extinguished.

b. Adjust Vertical Gain (A1R110) and Horizontal Gain (A1R87) for an 8.5 cm by 11.2 cm size pattern. It may be necessary to adjust Horizontal Position (A1R82) and Vertical Position (A1R105) for proper positioning.

c. Adjust Trace Align (A1R160) to align trace horizontally. Check for a pattern on screen as shown in figure 5-4.

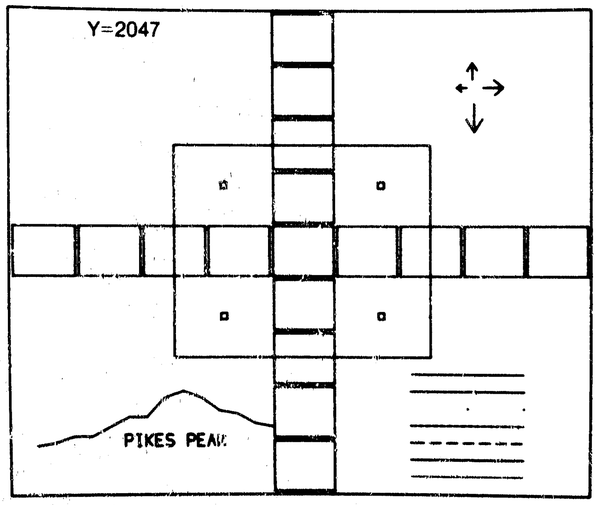


Figure 5-4. Primary Test Pattern Adjustment

ADJUSTMENTS

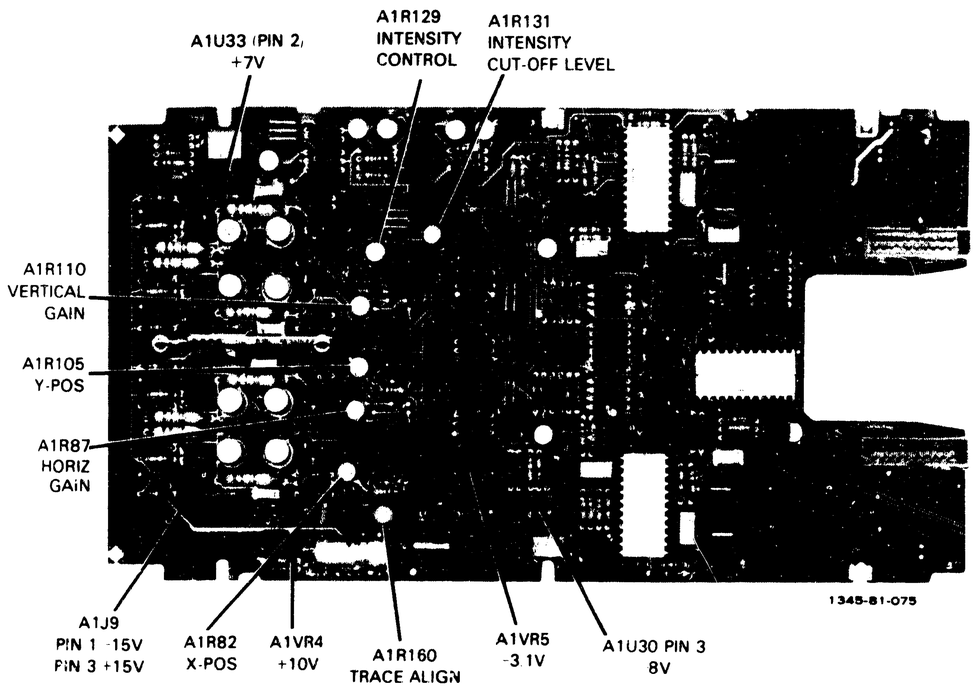


Figure 5-5. Primary Test Pattern Adjustment Locations

Table 5-4. Pattern Adjustment

Reference Designator	Adjustment Name	Adjustment Paragraph	Service Sheet	Description
A1R131	INTENSITY CUT-OFF LEVEL	5-13,a	3C	Adjust for minimum intensity of bright dots in pattern.
A1R110	VERTICAL GAIN	5-13,b	3C	Adjust for 8.5 cm high pattern.
A1R87	HORIZONTAL GAIN	5-13,b	3C	Adjust for 11.2 cm wide pattern.
A1R160	TRACE ALIGN	5-13,c	5	Adjust for a horizontally aligned pattern.
A1R82	HORIZONTAL POSITION	5-13,b	3C	As required.
A1R105	VERTICAL POSITION	5-13,b	3C	As required.

ADJUSTMENTS

5-14. STROKE GENERATOR ADJUSTMENTS.

Reference.
Service Sheets 3A, 3B.

Description:
This procedure describes the adjustments necessary to ensure proper vector stroke generation.

Equipment Required:
Power Supply
Power Connector (Option 325)

Procedure:

NOTE

The following procedures are referenced to figure 5-6. Perform the following adjustment steps in the same sequence as outlined below:

a. Display the primary test pattern as shown in figure 5-6.

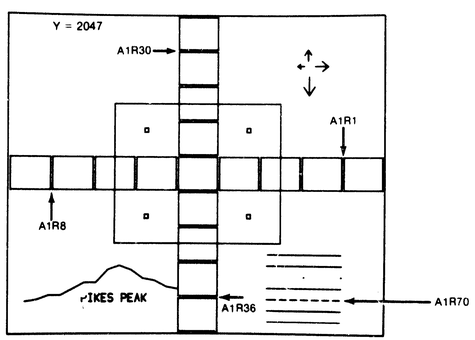


Figure 5-6. Stroke Generator Adjustment

b. Adjust A1R70 for the seven line segments. This step is a coarse adjustment for writing speed.

ADJUSTMENTS

c. Adjust A1R36 for parallel adjacent lines of the bottom two boxes in the test pattern.

d. Adjust A1R30 for parallel adjacent lines of the top two boxes in the test pattern.

e. Adjust A1R8 for parallel adjacent lines of the left two boxes in the test pattern.

f. Adjust A1R1 for parallel adjacent lines of the right two boxes in the test pattern.

g. All adjacent sides of the boxes in the test pattern should now be parallel. If not, repeat steps c through f.

NOTE

The following procedures are referenced to figure 5-7. Perform the following adjustment steps in the sequence outlined below:

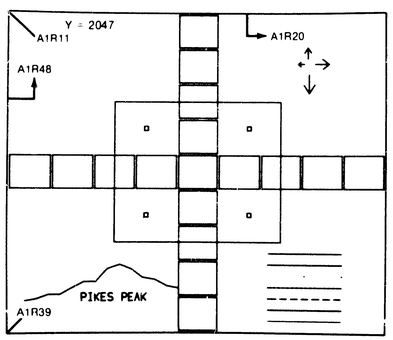


Figure 5-7. Test Pattern For Stroke Length Adjustment

h. Adjust A1R39 so that the left vertical line of the pattern starts at exactly the bottom horizontal line in the test pattern.

i. Adjust A1R48 so that the left vertical line ends at exactly the top horizontal line in the test pattern.

j. Adjust A1R11 so that the top horizontal line originates at exactly the left vertical line in the test pattern.

k. Adjust A1R20 so that the top horizontal line ends at exactly the right vertical line in the test pattern.

l. The outside box of the pattern should now be closed properly. If not, recheck steps h through k.

ADJUSTMENTS

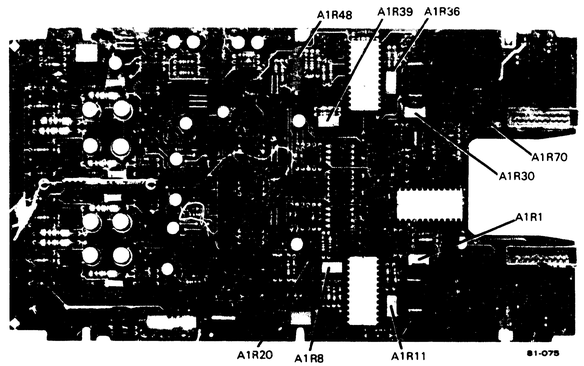


Figure 5-8. Stroke Generator and Stroke Length Adjustment Locations

Table 5-5. Stroke Generator Adjustment

Reference Designator	Adjustment Name	Adjustment Paragraph	Service Sheet	Description
A1R70	WRITING SPEED	5-14,b	3B	Adjust for seven segment line (figure 5-6).
A1R36	Y-STROKE OFFSET	5-14,c	3A	Parallel lines of bottom boxes in the test pattern (figure 5-6).
A1R30	Y-DAC GAIN	5-14,d	3A	Parallel lines of top boxes in the test pattern (figure 5-6).
A1R8	X-STROKE OFFSET	5-14,e	3A	Parallel lines of left boxes in the test pattern (figure 5-6).
A1R1	X-DAC GAIN	5-14,f	3A	Parallel lines of right boxes in the test pattern (figure 5-6).
A1R39	Y-RAMP OFFSET	5-14,h	3A	Left vertical line starts at bottom horizontal line in the test pattern (figure 5-7).
A1R48	Y-STROKE LENGTH	5-14,i	3A	Left vertical line length ends at top horizontal line in the test pattern (figure 5-7).
A1R11	X-RAMP OFFSET	5-14,j	3A	Top horizontal line starts at left vertical line in the test pattern (figure 5-7).
A1R20	X-STROKE LENGTH	5-14,k	3A	Top horizontal line ends at right vertical line in the test pattern (figure 5-7).

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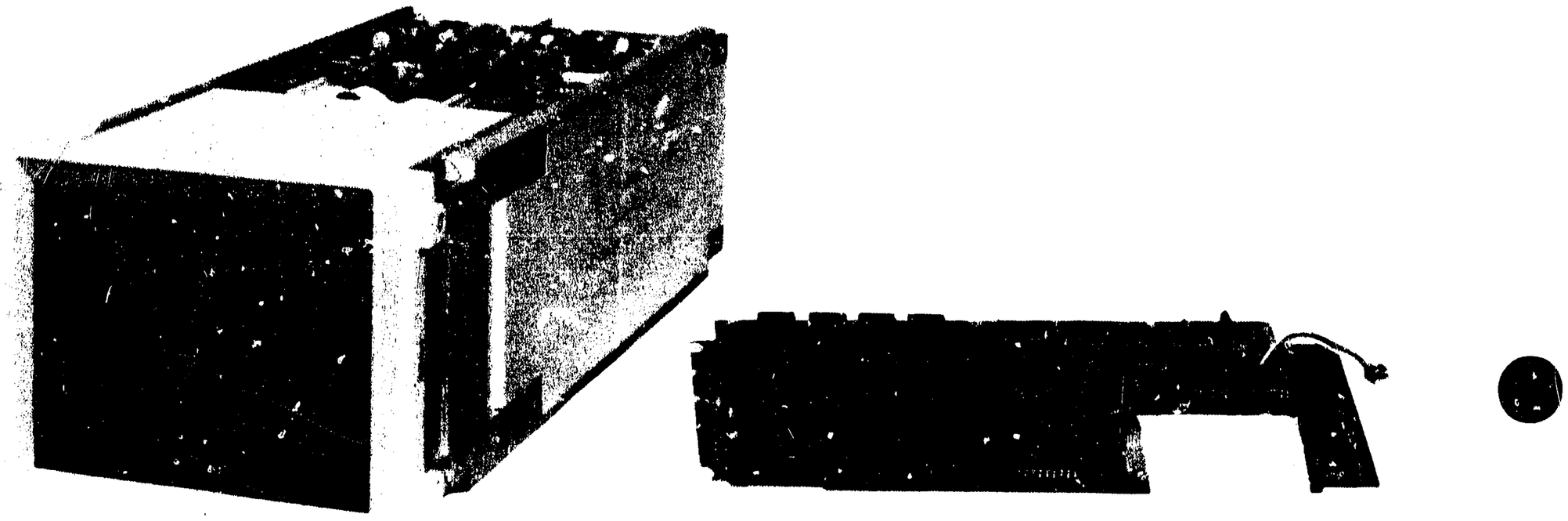


Figure 1-1. 1345A Digital Display with Option 704

Table 6-2. Replaceable Parts (Cont'd)

Reference Designator	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A1CR16	1901-0028	5		DIODE-PWR RECT 400V 750MA DO-29	28480	1901-0028
A1CR17	1901-0028	5		DIODE-PWR RECT 400V 750MA DO-29	28480	1901-0028
A1CR18	1901-0028	5		DIODE-PWR RECT 400V 750MA DO-29	28480	1901-0028
A1CR19	1901-0096	7		DIODE-SWITCHING 120V 50MA 100NS	28480	1901-0096
A1CR20	1901-0096	7		DIODE-SWITCHING 120V 50MA 100NS	28480	1901-0096
A1CR21	1901-0028	5		DIODE-PWR RECT 400V 750MA DO-29	28480	1901-0028
A1CR22	1901-0028	5		DIODE-PWR RECT 400V 750MA DO-29	28480	1901-0028
A1CR23	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A1CR24	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A1CR25	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A1E1	0360-1653	5	9	CONNECTOR-SGL CONT PIN .045-IN-BSC-SZ SQ	28480	0360-1653
A1E2	0360-1653	5		CONNECTOR-SGL CONT PIN .045-IN-BSC-SZ SQ	28480	0360-1653
A1E3	0360-1653	5		CONNECTOR-SGL CONT PIN .045-IN-BSC-SZ SQ	28480	0360-1653
A1E4	0360-1653	5		CONNECTOR-SGL CONT PIN .045-IN-BSC-SZ SQ	28480	0360-1653
A1E5	0360-1653	5		CONNECTOR-SGL CONT PIN .045-IN-BSC-SZ SQ	28480	0360-1653
A1E6	0360-1653	5		CONNECTOR-SGL CONT PIN .045-IN-BSC-SZ SQ	28480	0360-1653
A1E7	0360-1653	5		CONNECTOR-SGL CONT PIN .045-IN-BSC-SZ SQ	28480	0360-1653
A1E8	0360-1653	5		CONNECTOR-SGL CONT PIN .045-IN-BSC-SZ SQ	28480	0360-1653
A1E9	0360-1653	5		CONNECTOR-SGL CONT PIN .045-IN-BSC-SZ SQ	28480	0360-1653
A1E10	1258-0124	7	2	SHUNT-PROGRAMMABLE 1 DBL PIN SET .100	28480	1258-0124
A1E11	1258-0124	7		SHUNT-PROGRAMMABLE 1 DBL PIN SET .100	28480	1258-0124
A1J1	1251-5971	8	6	CONNECTOR 3-PIN M METRIC POST TYPE	28480	1251-5971
A1J2	1251-5971	8		CONNECTOR 3-PIN M METRIC POST TYPE	28480	1251-5971
A1J3	1251-4836	2	3	CONNECTOR 2-PIN M METRIC POST TYPE	28480	1251-4836
A1J4	1251-4836	2		CONNECTOR 2-PIN M METRIC POST TYPE	28480	1251-4836
A1J5	1251-4836	2		CONNECTOR 2-PIN M METRIC POST TYPE	28480	1251-4836
A1J6	1251-6823	1	2	CONNECTOR 20-PIN M POST TYPE	28480	1251-6823
A1J7	1251-6823	1		CONNECTOR 20-PIN M POST TYPE	28480	1251-6823
A1J8	1251-5863	7	1	CONNECTOR 5-PIN M METRIC POST TYPE	28480	1251-5863
A1J9	1251-5971	8		CONNECTOR 3-PIN M METRIC POST TYPE	28480	1251-5971
A1J10	1251-5971	8		CONNECTOR 3-PIN M METRIC POST TYPE	28480	1251-5971
A1J11	1251-5971	8		CONNECTOR 3-PIN M METRIC POST TYPE	28480	1251-5971
A1J12	1251-5971	8		CONNECTOR 3-PIN M METRIC POST TYPE	28480	1251-5971
A1MP1	1600-1038	1	1	SHIELD-AMPLIFIER	28480	1600-1038
A1MP2	1600-1148	4	1	SHIELD	28480	1600-1148
A1Q1	1855-0052	6	2	TRANSISTOR J-FET P-CHAN D-MODE TO-92 SI	07263	2N4360
A1Q2	1855-0052	6		TRANSISTOR J-FET P-CHAN D-MODE TO-92 SI	07263	2N4360
A1Q3	1853-0354	7	4	TRANSISTOR PNP SI TO-92 PD=350MW	28480	1853-0354
A1Q4	1853-0354	7		TRANSISTOR PNP SI TO-92 PD=350MW	28480	1853-0354
A1Q5	1853-0354	7		TRANSISTOR PNP SI TO-92 PD=350MW	28480	1853-0354
A1Q6	1853-0354	7		TRANSISTOR PNP SI TO-92 PD=350MW	28480	1853-0354
A1Q7	1853-0036	2	4	TRANSISTOR PNP SI PD=310MW FT=250MHZ	28480	1853-0036
A1Q8	1853-0038	4	4	TRANSISTOR PNP SI TO-39 PD=1W FT=100MHZ	28480	1853-0038
A1Q9	1854-0419	7	4	TRANSISTOR NPN SI TO-39 PD=1W FT=200MHZ	28480	1854-0419
A1Q10	1853-0038	4		TRANSISTOR PNP SI TO-39 PD=1W FT=100MHZ	28480	1853-0038
A1Q11	1854-0419	7		TRANSISTOR NPN SI TO-39 PD=1W FT=200MHZ	28480	1854-0419
A1Q12	1853-0036	2		TRANSISTOR PNP SI PD=310MW FT=250MHZ	28480	1853-0036
A1Q13	1853-0036	2		TRANSISTOR PNP SI PD=310MW FT=250MHZ	28480	1853-0036
A1Q14	1853-0038	4		TRANSISTOR PNP SI TO-39 PD=1W FT=100MHZ	28480	1853-0038
A1Q15	1854-0419	7		TRANSISTOR NPN SI TO-39 PD=1W FT=200MHZ	28480	1854-0419
A1Q16	1853-0038	4		TRANSISTOR PNP SI TO-39 PD=1W FT=100MHZ	28480	1853-0038
A1Q17	1854-0419	7		TRANSISTOR NPN SI TO-39 PD=1W FT=200MHZ	28480	1854-0419
A1Q18	1853-0036	2		TRANSISTOR PNP SI PD=310MW FT=250MHZ	28480	1853-0036
A1R1	2100-3350	5	2	RESISTOR-TMR 200 10% C SIDE ADJ 1-TRN	28480	2100-3350
A1R2	0757-0401	0	2	RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-TO-101-F
A1R3	0757-0418	9	2	RESISTOR 619 1% .125W F TC=0+-100	24546	C4-1/8-TO-619R-F
A1R4	0757-1094	9	2	RESISTOR 1.47K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1471-F
A1R5	0699-1011	6	12	RESISTOR 3.32K .1% .125W F TC=0+-100	28480	0699-1011
A1R6	0699-1011	6		RESISTOR 3.32K .1% .125W F TC=0+-100	28480	0699-1011
A1R7	0699-1011	6		RESISTOR 3.32K .1% .125W F TC=0+-100	28480	0699-1011
A1R8	2100-3288	8	4	RESISTOR-TRMR 50 20% C TOP-ADJ 17-TRN	28480	2100-3288
A1R9	0699-1011	6		RESISTOR 3.32K .1% .125W F TC=0+-100	28480	0699-1011
A1R10	0699-1011	6		RESISTOR 3.32K .1% .125W F TC=0+-100	28480	0699-1011
A1R11	2100-3288	8		RESISTOR-TRMR 50 20% C TOP-ADJ 17-TRN	28480	2100-3288
A1R12	0699-1011	6		RESISTOR 3.32K .1% .125W F TC=0+-100	28480	0699-1011
A1R13	0757-0439	4	3	RESISTOR 6.81K 1% .125W F TC=0+-100	24546	C4-1/8-TO-6811-F
A1R14	0698-3154	0	11	RESISTOR 4.22K 1% .125W F TC=0+-100	24546	C4-1/8-TO-4221-F
A1R15	0698-3154	0		RESISTOR 4.22K 1% .125W F TC=0+-100	24546	C4-1/8-TO-4221-F
A1R16	0757-0428	1	6	RESISTOR 1.62K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1621-F
A1R17	0757-0433	8	4	RESISTOR 3.32K 1% .125W F TC=0+-100	24546	C4-1/8-TO-3321-F
A1R18	0698-3154	0		RESISTOR 4.22K 1% .125W F TC=0+-100	24546	C4-1/8-TO-4221-F

See introduction to this section for ordering information

Table 6-2. Replaceable Parts (Cont'd)

Reference Designator	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A1R19	0757-0433	8		RESISTOR 3.32K 1% .125W F TC=0+-100	24546	C4-1/8-TO-3321-F
A1R20	2100-3659	6	2	RESISTOR-TRMR 20K 10% C TOP ADJ 17-TRN	32997	3292W-1-203
A1R21	0757-0280	3	7	RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1001-F
A1R22	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1001-F
A1R23	0757-0411	2	3	RESISTOR 332 1% .125W F TC=0+-100	24546	C4-1/8-TO-332R-F
A1R24	0757-0415	7	1	RESISTOR 475 1% .125W F TC=0+-100	24546	CT4-1/8-TO-475R-F
A1R25	0757-0402	1	1	RESISTOR 110 1% .125W F TC=0+-100	24546	C4-1/8-TO-111-F
A1R26	0757-0409	8	2	RESISTOR 274 1% .125W F TC=0+-100	24546	C4-1/8-TO-274R-F
A1R27	0698-3427	0	1	RESISTOR 13.3 1% .125W F TC=0+-100	03888	PME55-1/8-TO-13R3-F
A1R28	0698-3443	0	5	RESISTOR 287 1% .125W F TC=0+-100	24546	C4-1/8-TO-287-F
A1R29	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-TO-101-F
A1R30	2100-3350	5		RESISTOR-TMR 200 10% C SIDE ADJ 1-TRN	28480	2100-3350
A1R31	0757-0418	9		RESISTOR 619 1% .125W F TC=0+-100	24546	C4-1/8-TO-619R-F
A1R32	0757-1094	9		RESISTOR 1.47K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1471-F
A1R33	0699-1011	6		RESISTOR 3.32K .1% .125W F TC=0+-100	28480	0699-1011
A1R34	0699-1011	6		RESISTOR 3.32K .1% .125W F TC=0+-100	28480	0699-1011
A1R35	0699-1011	6		RESISTOR 3.32K .1% .125W F TC=0+-100	28480	0699-1011
A1R36	2100-3288	8		RESISTOR-TRMR 50 20% C TOP-ADJ 17-TRN	28480	2100-3288
A1R37	0699-1011	6		RESISTOR 3.32K .1% .125W F TC=0+-100	28480	0699-1011
A1R38	0699-1011	6		RESISTOR 3.32K .1% .125W F TC=0+-100	28480	0699-1011
A1R39	2100-3288	8		RESISTOR-TRMR 50 20% C TOP-ADJ 17-TRN	28480	2100-3288
A1R40	0699-1011	6		RESISTOR 3.32K .1% .125W F TC=0+-100	28480	0699-1011
A1R41	0757-0439	4		RESISTOR 6.81K 1% .125W F TC=0+-100	24546	C4-1/8-TO-6811-F
A1R42	0698-3154	0		RESISTOR 4.22K 1% .125W F TC=0+-100	24546	C4-1/8-TO-4221-F
A1R43	0698-3154	0		RESISTOR 4.22K 1% .125W F TC=0+-100	24546	C4-1/8-TO-4221-F
A1R44	0757-0428	1		RESISTOR 1.62K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1621-F
A1R45	0757-0433	8		RESISTOR 3.32K 1% .125W F TC=0+-100	24546	C4-1/8-TO-3321-F
A1R46	0698-3154	0		RESISTOR 4.22K 1% .125W F TC=0+-100	24546	C4-1/8-TO-4221-F
A1R47	0757-0433	8		RESISTOR 3.32K 1% .125W F TC=0+-100	24546	C4-1/8-TO-3321-F
A1R48	2100-3659	6		RESISTOR-TRMR 20K 10% C TOP ADJ 17-TRN	32997	3292W-1-203
A1R49	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1001-F
A1R50	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1001-F
A1R51	0757-0411	2		RESISTOR 332 1% .125W F TC=0+-100	24546	C4-1/8-TO-332R-F
A1R52	0757-0453	2	4	RESISTOR 30.1K 1% .125W F TC=0+-100	24546	C4-1/8-TO-3012-F
A1R53	0757-0431	6	1	RESISTOR 2.43K 1% .125W F TC=0+-100	24546	C4-1/8-TO-2431-F
A1R54	0683-1265	9	2	RESISTOR 12M 5% .25W FC TC=-900/+1200	01121	CB1265
A1R55	0757-0453	2		RESISTOR 30.1K 1% .125W F TC=0+-100	24546	C4-1/8-TO-3012-F
A1R56	2100-2497	9	5	RESISTOR-TRMR 2K 10% C TOP-ADJ 1-TRN	73138	82PR2K
A1R57	0757-0465	6	8	RESISTOR 100K 1% .125W F TC =0+-100	24546	C4-1/8-TO-1003-F
A1R58	0698-3443	0		RESISTOR 287 1% .125W F TC=0+-100	24546	C4-1/8-TO-287-F
A1R59	0698-3443	0		RESISTOR 287 1% .125W F TC=0+-100	24546	C4-1/8-TO-287-F
A1R60	0757-0465	6		RESISTOR 100K 1% .125W F TC =0+-100	24546	C4-1/8-TO-1003-F
A1R61	0757-0453	2		RESISTOR 30.1K 1% .125W F TC=0+-100	24546	C4-1/8-TO-3012-F
A1R62	0698-3151	7	2	RESISTOR 2.87K 1% .125W F TC=0+-100	24546	C4-1/8-TO-2871-F
A1R63	0683-1265	9		RESISTOR 12M 5% .25W FC TC=-900/+1200	01121	CB1265
A1R64	0757-0453	2		RESISTOR 30.1K 1% .125W F TC=0+-100	24546	C4-1/8-TO-3012-F
A1R65	2100-2497	9		RESISTOR-TRMR 2K 10% C TOP-ADJ 1-TRN	73138	82PR2K
A1R66	0757-0465	6		RESISTOR 100K 1% .125W F TC =0+-100	24546	C4-1/8-TO-1003-F
A1R67	0698-3443	0		RESISTOR 287 1% .125W F TC=0+-100	24546	C4-1/8-TO-287-F
A1R68	0698-3443	0		RESISTOR 287 1% .125W F TC=0+-100	24546	C4-1/8-TO-287-F
A1R69	0757-0465	6		RESISTOR 100K 1% .125W F TC =0+-100	24546	C4-1/8-TO-1003-F
A1R70	2100-3274	2	1	RESISTOR-TRMR 10K 10% C SIDE-ADJ 1-TRN	28480	2100-3274
A1R71	0757-0462	3	1	RESISTOR 75K 1% .125W F TC=0+-100	24546	C4-1/8-TO-7502-F
A1R72	0757-0409	8		RESISTOR 274 1% .125W F TC=0+-100	24546	C4-1/8-TO-274R-F
A1R73	0757-0459	8	1	RESISTOR 56.2K 1% F TC=0+-100	24546	C4-1/8-TO-5622-F
A1R74	0698-3151	7		RESISTOR 2.87K 1% .125W F TC=0+-100	24546	C4-1/8-TO-2871-F
A1R75	0757-0439	4		RESISTOR 6.81K 1% .125W F TC=0+-100	24546	C4-1/8-TO-6811-F
A1R76	0757-0406	5	1	RESISTOR 182 1% .125W F TC=0+-100	24546	C4-1/8-TO-182R-F
A1R77	0698-3156	2	1	RESISTOR 14.7K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1472-F
A1R78	0757-0442	9	6	RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1002-F
A1R79	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1002-F
A1R80	0757-0408	7	2	RESISTOR 243 1% .125W F TC=0+-100	24546	C4-1/8-TO-243R-F
A1R81	0698-3154	0		RESISTOR 4.22K 1% .125W F TC=0+-100	24546	C4-1/8-TO-4221-F
A1R82	2100-1788	9	2	RESISTOR-TRMR 500 10% C TOP-ADJ 1-TRN	73138	82PR500
A1R83	0757-0290	5	6	RESISTOR 6.19K 1% .125W F TC=0+-100	19701	MF4C1/8-TO-6191-F
A1R84	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1001-F
A1R85	0757-0428	1		RESISTOR 1.62K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1621-F
A1R86	0757-0416	7	7	RESISTOR 511 1% .125W F TC=0+-100	24546	C4-1/8-TO-511R-F
A1R87	2100-1986	9	3	RESISTOR-TRMR 1K 10% C TOP-ADJ 1-TRN	73138	82PR1K
A1R88	0757-0472	5	2	RESISTOR 200K 1% .125W F TC=0+-100	24546	C4-1/8-TO-2003-F
A1R89				NOT ASSIGNED		
A1R90	0757-0448	5	4	RESISTOR 18.2K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1822-F

Table 6-2. Replaceable Parts (Cont'd)

Reference Designator	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A1R81	0757-0419	0	5	RESISTOR 681 1% .125W F TC=0+-100	24546	C4-1/8-TO-681R-F
A1R82	0757-0847	8	8	RESISTOR 27.4K 1% .5W F TC=0+-100	28480	0757-0847
A1R83	0757-0290	5		RESISTOR 6.19K 1% .125W F TC=0+-100	19701	MF4C1/8-TO-6191-F
A1R84	0757-0465	6		RESISTOR 100K 1% .125W F TC =0+-100	24546	C4-1/8-TO-1003-F
A1R85	0757-0317	7	4	RESISTOR 1.33K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1331-F
A1R86	0757-0847	8		RESISTOR 27.4K 1% .5W F TC=0+-100	28480	0757-0847
A1R87	0757-0847	8		RESISTOR 27.4K 1% .5W F TC=0+-100	28480	0757-0847
A1R88	0757-0317	7		RESISTOR 1.33K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1331-F
A1R89	0757-0465	6		RESISTOR 100K 1% .125W F TC =0+-100	24546	C4-1/8-TO-1003-F
A1R100	0757-0290	5		RESISTOR 6.19K 1% .125W F TC=0+-100	19701	MF4C1/8-TO-6191-F
A1R101	0757-0847	8		RESISTOR 27.4K 1% .5W F TC=0+-100	28480	0757-0847
A1R102	0757-0419	0		RESISTOR 681 1% .125W F TC=0+-100	24546	C4-1/8-TO-681R-F
A1R103	0757-0448	5		RESISTOR 18.2K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1822-F
A1R104	0698-3154	0		RESISTOR 4.22K 1% .125W F TC=0+-100	24546	C4-1/8-TO-4221-F
A1R105	2100-1788	9		RESISTOR-TRMR 500 10% C TOP-ADJ 1-TRN	73138	82PR500
A1R106	0757-0290	5		RESISTOR 6.19K 1% .125W F TC=0+-100	19701	MF4C1/8-TO-6191-F
A1R107	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1001-F
A1R108	0757-0428	1		RESISTOR 1.62K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1621-F
A1R109	0757-0416	7		RESISTOR 511 1% .125W F TC=0+-100	24546	C4-1/8-TO-511R-F
A1R110	2100-1986	9		RESISTOR-TRMR 1K 10% C TOP-ADJ 1-TRN	73138	82PR1K
A1R111	0757-0472	5		RESISTOR 200K 1% .125W F TC=0+-100	24546	C4-1/8-TO-2003-F
A1R112				NOT ASSIGNED		
A1R113	0757-0448	5		RESISTOR 18.2K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1822-F
A1R114	0757-0419	0		RESISTOR 681 1% .125W F TC=0+-100	24546	C4-1/8-TO-681R-F
A1R115	0757-0847	8		RESISTOR 27.4K 1% .5W F TC=0+-100	28480	0757-0847
A1R116	0757-0290	5		RESISTOR 6.19K 1% .125W F TC=0+-100	19701	MF4C1/8-TO-6191-F
A1R117	0757-0465	6		RESISTOR 100K 1% .125W F TC =0+-100	24546	C4-1/8-TO-1003-F
A1R118	0757-0317	7		RESISTOR 1.33K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1331-F
A1R119	0757-0847	8		RESISTOR 27.4K 1% .5W F TC=0+-100	28480	0757-0847
A1R120	0757-0847	8		RESISTOR 27.4K 1% .5W F TC=0+-100	28480	0757-0847
A1R121	0757-0317	7		RESISTOR 1.33K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1331-F
A1R122	0757-0465	6		RESISTOR 100K 1% .125W F TC =0+-100	24546	C4-1/8-TO-1003-F
A1R123	0757-0290	5		RESISTOR 6.19K 1% .125W F TC=0+-100	19701	MF4C1/8-TO-6191-F
A1R124	0757-0847	8		RESISTOR 27.4K 1% .5W F TC=0+-100	28480	0757-0847
A1R125	0757-0419	0		RESISTOR 681 1% .125W F TC=0+-100	24546	C4-1/8-TO-681R-F
A1R126	0757-0448	5		RESISTOR 18.2K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1822-F
A1R127	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1002-F
A1R128	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1002-F
A1R129	2100-1986	9		RESISTOR-TRMR 1K 10% C TOP-ADJ 1-TRN	73138	82PR1K
A1R130	0698-0084	9	1	RESISTOR 2.15K 1% .125W F TC=0+-100	24546	C4-1/8-TO-2151-F
A1R131	2100-2497	9		RESISTOR-TRMR 2K 10% C TOP-ADJ 1-TRN	73138	82PR2K
A1R132	0757-0426	9	1	RESISTOR 1.3K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1301-F
A1R133	0757-0419	0		RESISTOR 681 1% .125W F TC=0+-100	24546	C4-1/8-TO-681R-F
A1R134	0757-0416	7		RESISTOR 511 1% .125W F TC=0+-100	24546	C4-1/8-TO-511R-F
A1R135	2100-2216	0	4	RESISTOR-TRMR 5K 10% C TOP-ADJ 1-TRN	73138	82PR5K
A1R136	0757-0273	4	2	RESISTOR 3.01K 1% .125W F TC=0+-100	24546	C4-1/8-TO-3011-F
A1R137	0757-0416	7		RESISTOR 511 1% .125W F TC=0+-100	24546	C4-1/8-TO-511R-F
A1R138	2100-2216	0		RESISTOR-TRMR 5K 10% C TOP-ADJ 1-TRN	73138	82PR5K
A1R139	0757-0273	4		RESISTOR 3.01K 1% .125W F TC=0+-100	24546	C4-1/8-TO-3011-F
A1R140	0698-3154	0		RESISTOR 4.22K 1% .125W F TC=0+-100	24546	C4-1/8-TO-4221-F
A1R141	0698-3154	0		RESISTOR 4.22K 1% .125W F TC=0+-100	24546	C4-1/8-TO-4221-F
A1R142	2100-2497	9		RESISTOR-TRMR 2K 10% C TOP-ADJ 1-TRN	73138	82PR2K
A1R143	0757-0408	7		RESISTOR 243 1% .125W F TC=0+-100	24546	C4-1/8-TO-243R-F
A1R144	0757-0416	7		RESISTOR 511 1% .125W F TC=0+-100	24546	C4-1/8-TO-511R-F
A1R145	2100-2497	9		RESISTOR-TRMR 2K 10% C TOP-ADJ 1-TRN	73138	82PR2K
A1R146	0698-3154	0		RESISTOR 4.22K 1% .125W F TC=0+-100	24546	C4-1/8-TO-4221-F
A1R147	0757-0283	6	2	RESISTOR 2K 1% .125W F TC=0+-100	24546	C4-1/8-TO-2001-F
A1R148	0757-0283	6		RESISTOR 2K 1% .125W F TC=0+-100	24546	C4-1/8-TO-2001-F
A1R149	2100-2216	0		RESISTOR-TRMR 5K 10% C TOP-ADJ 1-TRN	73138	82PR5K
A1R150	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1001-F
A1R151	0757-0407	6	4	RESISTOR 200 1% .125W F TC=0+-100	24546	C4-1/8-TO-201-F
A1R152	0757-0407	6		RESISTOR 200 1% .125W F TC=0+-100	24546	C4-1/8-TO-201-F
A1R153	0757-0407	6		RESISTOR 200 1% .125W F TC=0+-100	24546	C4-1/8-TO-201-F
A1R154	0757-0407	6		RESISTOR 200 1% .125W F TC=0+-100	24546	C4-1/8-TO-201-F
A1R155	0757-0428	1		RESISTOR 1.62K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1621-F
A1R156	0757-0411	2		RESISTOR 332 1% .125W F TC=0+-100	24546	C4-1/8-TO-332R-F
A1R157	0698-3445	2	1	RESISTOR 348 1% .125W F TC=0+-100	24546	C4-1/8-TO-348R-F
A1R158	0757-0428	1		RESISTOR 1.62K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1621-F
A1R159	0757-0714	8	1	RESISTOR 130 1% .25W F TC=0+-100	24546	C5-1/4-TO-131-F
A1R160	2100-2216	0		RESISTOR-TRMR 5K 10% C TOP-ADJ 1-TRN	73138	82PR5K
A1R161	0698-3438	3	1	RESISTOR 147 1% .125W F TC=0+-100	28480	0698-3438
A1R162	0757-0421	4	1	RESISTOR 825 1% .125W F TC=0+-100	28480	0757-0421
A1R163	0757-0416	7		RESISTOR 511 1% .125W F TC=0+-100	24546	C4-1/8-TO-511R-F

Table 6-2. Replaceable Parts (Cont'd)

Reference Designator	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A1R164	0757-0416	7		RESISTOR 511 1% .125W F TC=0+-100	24546	C4-1/8-TO-511R-F
A1R165	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1002-F
A1R166	0757-0394	0	2	RESISTOR 51.1 1% .125W F TC=0+-100	24546	C4-1/8-TO-51R1-F
A1R167	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1002-F
A1R168	0757-0394	0		RESISTOR 51.1 1% .125W F TC=0+-100	24546	C4-1/8-TO-51R1-F
A1R169	8159-0005	0	1	RESISTOR-ZERO OHMS 22AWG LEAD DIA	28480	8159-0005
A1TP1				NOT ASSIGNED		
A1TP2	0360-0535	0	4	TERMINAL TEST POINT PCB	28480	0360-0535
A3TP3				NOT ASSIGNED		
A3TP4				NOT ASSIGNED		
A3TP5				NOT ASSIGNED		
A3TP6				NOT ASSIGNED		
A1TP7	0360-0535	0		TERMINAL TEST POINT PCB	28480	0360-0535
A1TP8	0360-0535	0		TERMINAL TEST POINT PCB	28480	0360-0535
A1TP9	0360-0535	0		TERMINAL TEST POINT PCB	28480	0360-0535
A1U1	1820-1196	8	4	IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS174N
A1U2	1820-1196	8		IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS174N
A1U3	1826-0860	3	4	IC CONV 12-B-D/A 24-DIP-C PKG	34371	HI1-562A-5
A1U4	1826-0860	3		IC CONV 12-B-D/A 24-DIP-C PKG	34371	HI1-562A-5
A1U5	1826-0930	4	6	IC OP AMP LOW-BIAS-H-IMPD TO99 PKG	28480	1826-0930
A1U6	1826-0930	4		IC OP AMP LOW-BIAS-H-IMPD TO99 PKG	28480	1826-0930
A1U7	1NB4-5003	4	2	ANALOG MULTI PACK	28480	1NB4-5003
A1U8	1826-0207	2	4	IC OP AMP WB 8-DIP-P PKG	01295	LM318P
A1U9	1826-0207	2		IC OP AMP WB 8-DIP-P PKG	01295	LM318P
A1U10	1826-0930	4		IC OP AMP LOW-BIAS-H-IMPD TO99 PKG	28480	1826-0930
A1U11	1826-0208	3	3	IC OP AMP GP 8-DIP-P PKG	27014	LM310N
A1U12	1826-0753	3	2	IC OP AMP LOW-BIAS-H IMPD QUAD 14-DIP-C	04713	MC34C04BL
A1U13	1820-1196	8		IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS174N
A1U14	1820-1196	8		IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS174N
A1U15	1826-0860	3		IC CONV 12-B-D/A 24-DIP-C PKG	34371	HI1-562A-5
A1U16	1826-0860	3		IC CONV 12-B-D/A 24-DIP-C PKG	34371	HI1-562A-5
A1U17	1826-0930	4		IC OP AMP LOW-BIAS-H-IMPD TO99 PKG	28480	1826-0930
A1U18	1826-0930	4		IC OP AMP LOW-BIAS-H-IMPD TO99 PKG	28480	1826-0930
A1U19	1NB4-5003	4		ANALOG MULTI PACK	28480	1NB4-5003
A1U20	1826-0207	2		IC OP AMP WB 8 DIP-P PKG	01295	LM318P
A1U21	1826-0207	2		IC OP AMP WB 8-DIP-P PKG	01295	LM318P
A1U22	1826-0930	4		IC OP AMP LOW-BIAS-H-IMPD TO99 PKG	28480	1826-0930
A1U23	1826-0208	3		IC OP AMP GP 8-DIP-P PKG	27014	LM310N
A1U24	1826-0208	3		IC OP AMP GP 8-DIP-P PKG	27014	LM310N
A1U25	1826-0818	1	1	IC 16-DIP-C PKG	28480	1826-0818
A1U26	1NB4-5004	5	1	RAMP GENERATOR	23480	1NB4-5004
A1U27	1826-0871	6	3	IC LINEAR	28480	1826-0871
A1U28	1826-0871	6		IC LINEAR	28480	1826-0871
A1U29	1826-0871	6		IC LINEAR	28480	1826-0871
A1U30	1826-0527	9	1	IC V RGLTR TO-220	04713	MC7915CT
A1U31	1826-0753	3		IC OP AMP LOW-BIAS-H IMPD QUAD 14-DIP-C	04713	MC34004BL
A1U32				NOT ASSIGNED		
A1U33	1826-0393	7	1	IC V RGLTR TO-220	27014	LM317T
A1VR1	1826-0825	0	1	IC-VOLTAGE REGULATOR	28480	1826-0825
A1VR2	1902-0025	4	3	DIODE-ZNR 10V 5% DO-35 PD=.4W TC=+.06%	28480	1902-0025
A1VR3	1902-0025	4		DIODE-ZNR 10V 5% DO-35 PD=.4W TC=+.06%	28480	1902-0025
A1VR4	1902-0025	4		DIODE-ZNR 10V 5% DO-35 PD=.4W TC=+.06%	28480	1902-0025
A1VR5	1902-3036	3	1	DIODE-ZNR 3.16V 5% DO-7 PD=.4W TC=-.064%	28480	1902-3036
A1VR6	1902-0048	1	2	DIODE-ZNR 6.81V 5% DO-35 PD=.4W	28480	1902-0048
A1VR7	1902-0048	1		DIODE-ZNR 6.81V 5% DO-35 PD=.4W	28480	1902-0048
A1VR8	1902-3070	5	4	DIODE-ZNR 4.22V 5% DO-35 PD=.4W	28480	1902-3070
A1VR9	1902-3070	5		DIODE-ZNR 4.22V 5% DO-35 PD=.4W	28480	1902-3070
A1VR10	1902-3070	5		DIODE-ZNR 4.22V 5% DO-35 PD=.4W	28480	1902-3070
A1VR11	1902-3070	5		DIODE-ZNR 4.22V 5% DO-35 PD=.4W	28480	1902-3070
A1XU3	1200-0541	1	7	SOCKET-IC 24-CONT DIP DIP-SLDR	28480	1200-0541
A1XU4	1200-0541	1		SOCKET-IC 24-CONT DIP DIP-SLDR	28480	1200-0541
A1XU7	1200-0541	1		SOCKET-IC 24-CONT DIP DIP-SLDR	28480	1200-0541
A1XU15	1200-0541	1		SOCKET-IC 24-CONT DIP DIP-SLDR	28480	1200-0541
A1XU18	1200-0541	1		SOCKET-IC 24-CONT DIP DIP-SLDR	28480	1200-0541
A1XU19	1200-0541	1		SOCKET-IC 24-CONT DIP DIP-SLDR	28480	1200-0541
A1XU25	1200-0607	0	1	SOCKET-IC 16-CONT DIP DIP-SLDR	28480	1200-0607
A1XU26	1200-0541	1		SOCKET-IC 24-CONT DIP DIP-SLDR	28480	1200-0541

Table 6-2. Replaceable Parts (Cont'd)

Reference Designator	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A2	01345-66527	8	1	BOARD ASSY-VPC	28480	01345-66527
A2C1	0160-2264	2	2	CAPACITOR-FXD 20PF +-5% 500VDC CER 0+-30	28480	0160-2264
A2C2	0160-2264	2		CAPACITOR-FXD 20PF +-5% 500VDC CER 0+-30	28480	0160-2264
A2C3	0180-0291	3	1	CAPACITOR-FXD 1UF +-10% 35VDC TA	56289	150D105X9035A2
A2C4	0160-5298	8	16	CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-5298
A2C5	0160-5298	8		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-5298
A2C6	0160-5298	8		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-5298
A2C7	0160-5298	8		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-5298
A2C8	0160-5298	8		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-5298
A2C9	0160-5298	8		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-5298
A2C10	0160-5298	8		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-5298
A2C11	0160-5298	8		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-5298
A2C12	0160-5468	4	1	CAPACITOR-FXD .47UF +-10% 50VDC	28480	0160-5468
A2C13	0160-3443	1	4	CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	0160-3443
A2C14	0160-5298	8		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-5298
A2C15	0160-5298	8		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-5298
A2C16	0160-5298	8		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-5298
A2C17	0160-5298	8		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-5298
A2C18	0160-5296	8		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-5298
A2C19	0160-3443	1		CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	0160-3443
A2C20	0160-5298	8		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-5298
A2C21	0160-5298	8		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-5298
A2C22	0160-3443	1		CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	0160-3443
A2C23	0160-3443	1		CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	0160-3443
A2C24	0160-5298	8		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-5298
A2CR1	1901-0010	1	1	DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A2CR2	1901-1065	2	2	DIODE-PWR RECT 400V 1A	14433	1N4936
A2CR3	1901-1065	2		DIODE-PWR RECT 400V 1A	14433	1N4936
A2E1	1258-0124	7	1	SHUNT-PROGRAMMABLE 1 DBL PIN SET .100	28480	1258-0124
A2H1	3050-0367	2	1	WASHER-FL MTLC NO. 3 .105-IN-ID	28480	3050-0367
A2H2	0515-0403	0	1	SCREW-MACH M2.5 X 0.45 4MM-LG PAN-HD	28480	0515-0403
A2H3	0535-0008	3	1	NUT-HEX DBL-CHAM M2.5 X 0.45 2MM THK	28480	0535-0008
A2J1	1251-8262	6	1	CONN-POST TYPE .100-PIN-SPCG 50-CONT	28480	1251-8262
A2J2	1251-6823	1	2	CONN-POST TYPE .100-PIN-SPCG 20-CONT	28480	1251-6823
A2J3	1251-6823	1		CONN-POST TYPE .100-PIN-SPCG 20-CONT	28480	1251-6823
A2J4	1251-7229	3	1	CONN-POST TYPE .100-PIN-SPCG 26-CONT	28480	1251-7229
A2J5	1251-6000	6	1	CONN-POST TYPE 2.5-PIN-SPCG 5-CONT	28480	1251-6000
A2J6	1251-4836	2	1	CONN-POST TYPE 2.5-PIN-SPCG 2-CONT	28480	1251-4836
A2L1	9100-1629	4	1	INDUCTOR RF-CH-MLD 47UH 5% .166DX.385LG	28480	9100-1629
A2Q1	1854-0300	5	1	TRANSISTOR NPN SI PD=21W FT=10MHZ	28480	1854-0300
A2Q2	1854-0215	1	1	TRANSISTOR NPN SI PD=350MW FT=300MHZ	04713	2N3904
A2R1				NOT ASSIGNED		
A2R2	0757-0[illegible]	3	2	RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1001-F
A2R3	0683-[illegible]275	9	1	RESISTOR 2.7 5% .25W CF TC=0-400	19701	(CR-25)1-4-5P-2R7
A2R4	0683-[illegible]1035	1	1	RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A2R5	0757-[illegible]0273	4	1	RESISTOR 3.01K 1% .125W F TC=0+-100	24546	C4-1/8-TO-3011-F
A2R6	0757-0416	7	2	RESISTOR 511 1% .125W F TC=0+-100	24546	C4-1/8-TO-511R-F
A2R7	0757-0449	6	1	RESISTOR 20K 1% .125W F TC=0+-100	24546	C4-1/8-2002-F
A2R8	0757-0159	5	1	RESISTOR 1K 1% .5W F TC=0+-100	28480	0757-0159
A2R9	0698-3394	4	1	RESISTOR 31.6 1% .5W F TC=0+-100	28480	0698-3394
A2R10	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1001-F
A2R11	0698-3154	0	1	RESISTOR 4.22K 1% .125W F TC=0+-100	24546	C4-1/8-TO-4221-F
A2R12	0757-0416	7		RESISTOR 511 1% .125W F TC=0+-100	24546	C4-1/8-TO-511R-F
A2R13	0761-0035	5	1	RESISTOR 150 5% 1W MO TC=0+-200	28480	0761-0035
A2RP1	1810-0206	8	1	NETWORK-RES 8-DIP 10.0K OHM X 7	01121	208A103
A2RP2	1810-0204	6	1	NETWORK-RES 8-DIP 1.0K OHM X 7	01121	208A102
A2TP1	0360-0535	0	5	TERMINAL-TEST POINT .330IN ABOVE	28480	0360-0535
A2TP2	0360-0535	0		TERMINAL-TEST POINT .330IN ABOVE	28480	0360-0535
A2TP3	0360-0535	0		TERMINAL-TEST POINT .330IN ABOVE	28480	0360-0535
A2TP4	0360-0535	0		TERMINAL-TEST POINT .330IN ABOVE	28480	0360-0535
A2TP5	0360-0535	0		TERMINAL-TEST POINT .330IN ABOVE	28480	0360-0535
A2U1	01347-80010	6	1	IC 8748 DOT/NISO	28480	01347-80010
A2U2	1820-1297	0	1	IC GATE TTL LS EXCL-NOR QUAD 2-INP	01295	SN74LS266N
A2U3	1810-0307	0	2	NETWORK-CNDCT MODULE DIP; 16 PINS; 0.100	28480	1810-0307
A2U4	1810-0307	0		NETWORK-CNDCT MODULE DIP; 16 PINS; 0.100	28480	1810-0307
A2U5	1816-1500	9	1	IC TTL S 4096 (4K) PROM 85-NS 3-S	01295	TBP18S42N
A2U6	1820-2024	7	5	IC DRVR TTL LS LINE DRVR OCTL	01295	SN74LS244N
A2U7	1820-1108	0	1	IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS03N

Table 6-2. Replaceable Parts (Cont'd)

Reference Designator	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A2U8	1820-2024	7		IC DRVR TTL LS LINE DRVR OCTL	01295	SN74LS244N
A2U9	1820-1432	5	4	IC CNTR TTL LS BIN SYNCHRO POS-EDGE-TRIG	01295	SN74LS163AN
A2U10	1820-1432	5		IC CNTR TTL LS BIN SYNCHRO POS-EDGE-TRIG	01295	SN74LS163AN
A2U11	1820-1432	5		IC CNTR TTL LS BIN SYNCHRO POS-EDGE-TRIG	01295	SN74LS163AN
A2U12	01347-80012	8	1	IC D2732A-3 PRGD	28480	01347-80012
A2U13	1820-2024	7		IC DRVR TTL LS LINE DRVR OCTL	01295	SN74LS244N
A2U14	1813-0148	4	1	IC OSC HYBRID	34344	K1148A-19.6608MHZ
A2U15	1820-1322	2	1	IC GATE TTL S NOR QUAD 2-INP	01295	SN74S02N
A2U16	1SB5-0025	8	1	VPC B2DZ PROC	28480	1SB5-0025
A2U17	1820-2024	7		IC DRVR TTL LS LINE DRVR OCTL	01295	SN74LS244N
A2U18	1820-1997	7	2	IC FF TTL LS D-TYPE POS-EDGE-TRIG PRL-IN	01295	SN74LS374N
A2U19	1820-1997	7		IC FF TTL LS D-TYPE POS-EDGE-TRIG PRL-IN	01295	SN74LS374N
A2U20	1820-1444	9	1	IC MUXR/DATA-SEL TTL LS 2-TO-1 LINE QUAD	01295	SN74LS298N
A2U21	1820-1422	3	1	IC MV TTL LS MONOSTBL RETRIG	01295	SN74LS122N
A2U22	1820-1196	8	4	IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS174N
A2U23	1820-1196	8		IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS174N
A2U24	1820-1196	8		IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS174N
A2U25	1820-1196	8		IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS174N
A2U26	1820-1432	5		IC CNTR TTL LS BIN SYNCHRO POS-EDGE-TRIG	01295	SN74LS163AN
A2U27	1820-1217	4	1	IC MUXR/DATA-SEL TTL LS 8-TO-1 LINE	01295	SN74LS151N
A2U28	1820-2024	7		IC DRVR TTL LS LINE DRVR OCTL	01295	SN74LS244N
A2VR1	1902-3126	2	1	DIODE-ZNR 7.15V 2% DO-35 PD=.4W	28480	1902-3126
A2XU1	1200-0654	7	2	SOCKET-IC 40-CONT DIP DIP-SLDR	28480	1200-0654
A2XU3	1200-0607	0	2	SOCKET-IC 16-CONT DIP DIP-SLDR	28480	1200-0607
A2XU4	1200-0607	0		SOCKET-IC 16-CONT DIP DIP-SLDR	28480	1200-0607
A2XU5	1200-0639	8	1	SOCKET-IC 20-CONT DIP DIP-SLDR	28480	1200-0639
A2XU12	1200-0541	1	1	SOCKET-IC 24-CONT DIP DIP-SLDR	28480	1200-0541
A2XU16	1200-0654	7		SOCKET-IC 40-CONT DIP DIP-SLDR	28480	1200-0654

Table 6-2. Replaceable Parts (Cont'd)

Reference Designator	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A3	01345-66509	6	1	BOARD ASSEMBLY-LV	28480	01345-66509
A3C1	0180-0094	4	1	CAPACITOR-FXD 100UF +75-10% 25VDC AL	56289	30D107G025DD2
A3C2	0160-3443	1	1	CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	0160-3443
A3C3	0180-0106	9	1	CAPACITOR-FXD 60UF +-20% 6VDC TA	56289	150D606X0006B2
A3C4	0160-3448	6	1	CAPACITOR-FXD 1000PF +-10% 1KVDC CER	28480	0160-3448
A3C5	0160-0207	9	1	CAPACITOR-FXD .01UF +-5% 200VDC POLYE	28480	0160-0207
A3C6	0180-1819	3	1	CAPACITOR-FXD 100UF +75-10% 50VDC AL	56289	30D107G050DH2
A3C7	0180-2089	1	1	CAPACITOR-FXD 100UF +50-10% 150VDC AL	56289	39D107F150FP4
A3CR1	1901-0040	1	2	DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A3CR2	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A3CR3	1901-0669	0	2	DIODE-PWR RECT 400V 1A 150NS	28480	1901-0669
A3CR4	1901-0669	0		DIODE-PWR RECT 400V 1A 150NS	28480	1901-0669
A3F1	2110-0303	3	1	FUSE 2.0A 250V TD 1.25 X .25 UL	28480	2110-0303
A3F2	2110-0367	9	1	FUSE 5.0A 250V TD 1.25 X .25 UL	28480	2110-0367
A3F3	2110-0001	8	1	FUSE 1.0A 250V NTD 1.25 X .25 UL	28480	2110-0001
A3H1	0340-0114	9	1	INSULATOR-FLG-BSHG NYLON	28480	0340-0114
A3H2	2110-0269	0	1	FUSEHOLDER-CLIP TYPE .250-FUSE	28480	2110-0269
A3H3	2190-0584	0	1	WASHER-LK HLCL NO. 4 .115-IN-ID	28480	2190-0584
A3H4	0515-0403	0	2	SCREW-MACH 4-40 .312-IN-LG PAN-HD-POZI	28480	0515-0403
A3H5	0515-0065	0	1	SCREW MACH 4-40 .875-IN-LG PAN HD-POZI	28480	0515-0065
A3H6	3050-0367	2	2	WASHER-FL MTLC NO. 4 .125-IN-ID	28480	3050-0367
A3J1	1251-4308	3	1	CONNECTOR 6-PIN M UTILITY	28480	1251-4308
A3J2	1251-5863	7	3	CONNECTOR 5-PIN M METRIC POST TYPE	28480	1251-5863
A3J3	1251-5863	7		CONNECTOR 5-PIN M METRIC POST TYPE	28480	1251-5863
A3J4	1251-5863	7		CONNECTOR 5-PIN M METRIC POST TYPE	28480	1251-5863
A3J5	1251-6091	5	1	CONNECTOR 2-PIN M METRIC POST TYPE	28480	1251-6091
A3L1	9100-3139	5	2	INDUCTOR 75UH 15% .5DX.875LG	28480	9100-3139
A3L2	9140-0137	1	1	INDUCTOR RF-CH-MLD 1MH 5% .2DX.45LG Q=60	28480	9140-0137
A3L3	9100-3139	5		INDUCTOR 75UH 15% .5DX.875LG	28480	9100-3139
A3MP1	01345-04101	4	1	COVER LV	28480	01345-04101
A3Q1	1854-0659	7	2	TRANSISTOR NPN SI PD=12.5W FT=50MHZ	04713	MJE180
A3Q2	1854-0659	7		TRANSISTOR NPN SI PD=12.5W FT=50MHZ	04713	MJE180
A3R1	0757-0438	3	2	RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4-1/8-TO-5111-F
A3R2	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4-1/8-TO-5111-F
A3R3	0757-0449	6	1	RESISTOR 20K 1% .125W F TC=0+-100	24546	C4-1/8-TO-2002-F
A3R4	0698-0085	0	1	RESISTOR 2.61K 1% .125W F TC=0+-100	24546	C4-1/8-TO-2611-F
A3R5	0757-0720	6	1	RESISTOR 243 1% .25W F TC=0+-100	24546	C5-1/4-TO-243R-F
A3R6	0757-0401	0	2	RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-TO-101-F
A3R7	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-TO-101-F
A3R8	0811-3293	0	1	RESISTOR .18 5% 2W PW TC=0+-800	28480	0811-3293
A3R9	0757-0466	7	1	RESISTOR 110K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1103-F
A3R10	2100-0554	5	1	RESISTOR-TRMR 500 10% C TOP-ADJ 1-TRN	28480	2100-0554
A3R11	0757-0431	6	1	RESISTOR 2.43K 1% .125W F TC=0+-100	24546	C4-1/8-TO-2431-F
A3T1	01345-61102	5	1	TRANS ASSEMBLY	28480	01345-61102
A3TP1	0360-0535	0	4	TERMINAL-TEST POINT	28480	0360-0535
A3TP2	0360-0535	0		TERMINAL-TEST POINT	28480	0360-0535
A3TP3	0360-0535	0		TERMINAL-TEST POINT	28480	0360-0535
A3TP4	0360-0535	0		TERMINAL-TEST POINT	28480	0360-0535
A3U1	1826-0428	9	1	IC 3524 MODULATOR 16-DIP-C	01295	SG3524J
A3XU1	1200-0607	0	1	SOCKET-IC 16-CONT DIP DIP-SLDR	28480	1200-0607

Table 6-2. Replaceable Parts (Cont'd)

Reference Designator	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A4	01345-66523	4	1	BOARD ASSEMBLY-HV	28480	01345-66523
A4A1	0960-0629	5	1	MULTIPLIER-H.V.	28480	0960-0629
A4C1	0160-2205	1	1	CAPACITOR-FXD 120PF +-5% 300VDC MICA	28480	0160-2205
A4C2	0160-2234	6	2	CAPACITOR-FXD .51PF +-.25PF 500VDC CER	28480	0160-2234
A4C3	0160-3665	9	5	CAPACITOR-FXD .01UF +80-20% 500VDC CER	28480	0160-3065
A4C4	0160-3638	6	2	CAPACITOR-FXD .22UF +80-20% 200VDC CER	28480	0160-3638
A4C5	0160-2055	9	1	CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A4C6	0160-3665	9		CAPACITOR-FXD .01UF +80-20% 500VDC CER	28480	0160-3665
A4C7	0160-3638	6		CAPACITOR-FXD .22UF +80-20% 200VDC CER	28480	0160-3638
A4C8	0180-0098	8	2	CAPACITOR-FXD 100UF +-20% 20VDC TA	56289	150D107X0020S2
A4C9	0180-0098	8		CAPACITOR-FXD 100UF +-20% 20VDC TA	56289	150D107X0020S2
A4C10	0160-0165	8	1	CAPACITOR-FXD .056UF +-10%200VDC POLYE	28480	0160-0165
A4C11	0160-3443	1	1	CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	0160-3443
A4C12	0160-4051	9	3	CAPACITOR-FXD .01UF +-20% 4KVDC	28480	0160-4051
A4C13	0160-4051	9		CAPACITOR-FXD .01UF +-20% 4KVDC	28480	0160-4051
A4C14	0160-2264	2	1	CAPACITOR-FXD 20PF +-5% 500VDC CER 0+-30	28480	0160-2264
A4C15	0160-0684	6	2	CAPACITOR-FXD 1000PF +-20% 4KVDC	28480	0160-0684
A4C16	0160-0684	6		CAPACITOR-FXD 1000PF +-20% 4KVDC	28480	0160-0684
A4C17	0160-4051	9		CAPACITOR-FXD .01UF +-20% 4KVDC	28480	0160-4051
A4C18	0160-3665	9		CAPACITOR-FXD .01UF +80-20% 500VDC CER	28480	0160-3665
A4C19	0160-3665	9		CAPACITOR-FXD .01UF +80-20% 500VDC CER	28480	0160-3665
A4C20	0160-5337	6	1	CAPACITOR-FXD 30PF +-20% 3KVDC CER	28480	0160-5337
A4C21	0160-5336	5	1	CAPACITOR-FXD 20PF +-20% 3KVDC CER	28480	0160-5336
A4C22	0160-0162	5	1	CAPACITOR-FXD .022UF +-10% 200VDC POLYE	28480	0160-0162
A4C23	0160-2234	6		CAPACITOR-FXD .51PF +-.25PF 500VDC CER	28480	0160-2234
A4C24	0160-3665	9		CAPACITOR-FXD .01UF +80-20% 500VDC CER	28480	0160-3665
A4CR1	1901-0028	5	10	DIODE-PWR RECT 400V 750MA DO-29	28480	1901-0028
A4CR2	1901-0096	7	2	DIODE-SWITCHING 120V 50MA 100NS	28480	1901-0096
A4CR3	1901-0028	5		DIODE-PWR RECT 400V 750MA DO-29	28480	1901-0028
A4CR4	1901-0028	5		DIODE-PWR RECT 400V 750MA DO-29	28480	1901-0028
A4CR5	1901-0096	7		DIODE-SWITCHING 120V 50MA 100NS	28480	1901-0096
A4CR6	1901-0028	5		DIODE-PWR RECT 400V 750MA DO-29	28480	1901-0028
A4CR7	1901-0040	1	2	DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A4CR8	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A4CR9	1901-0028	5		DIODE-PWR RECT 400V 750MA DO-29	28480	1901-0028
A4CR10	1901-0028	5		DIODE-PWR RECT 400V 750MA DO-29	28480	1901-0028
A4CR11	1901-0683	8	1	DIODE-HV RECT 10KV 5MA 250NS	28480	1901-0683
A4CR12	1901-0028	5		DIODE-PWR RECT 400V 750MA DO-29	28480	1901-0028
A4CR13	1901-0028	5		DIODE-PWR RECT 400V 750MA DO-29	28480	1901-0028
A4CR14	1901-0028	5		DIODE-PWR RECT 400V 750MA DO-29	28480	1901-0028
A4CR15	1901-0028	5		DIODE-PWR RECT 400V 750MA DO-29	28480	1901-0028
A4E1	0360-1653	5	12	CONNECTOR-SGL CONT PIN .045-IN-BSC-SZ SQ	28480	0360-1653
A4H1	0515-0055	8	2	SCREW-MACH M3 x 0.5 6MM-LG PAN-HD	28480	0515-0055
A4H2	0515-0055	8		SCREW-MACH M3 x 0.5 6MM-LG PAN-HD	28480	0515-0055
A4J1	1251-5863	7	1	CONNECTOR 5-PIN M METRIC POST TYPE	28480	1251-5863
A4J11	1251-5971	8	1	CONN-POST TYPE 2.5-PIN-SPCG 3-CONT	28480	1251-5971
A4L1	9140-0115	5	1	INDUCTOR RF-CH-MLD 22UH 10% .23DX.57LG	28480	9140-0115
A4MP1	01345-04103	6	1	COVER-HV INNER	28480	01345-04103
A4Q1	1854-0215	1	2	TRANSISTOR NPN SI PD=350MW FT=300MHZ	04713	2N3904
A4Q2	1853-0038	4	2	TRANSISTOR PNP SI TO-39 PD=1W FT=100MHZ	28480	1853-0038
A4Q3	1854-0419	7	2	TRANSISTOR NPN SI TO-39 PD=1W FT=200MHZ	28480	1854-0419
A4Q4	1854-0215	1		TRANSISTOR NPN SI PD=350MW FT=300MH	04713	2N3904
A4Q5	1853-0038	4		TRANSISTOR PNP SI TO-39 PD=1W FT=100MHZ	28480	1853-0038
A4Q6	1854-0419	7		TRANSISTOR NPN SI TO-39 PD=1W FT=200MHZ	28480	1854-0419
A4Q7	1854-0433	5	1	TRANSISTOR NPN SI PD=90W FT=2MHZ	28480	1854-0433
A4R1	0684-6811	3	5	RESISTOR 680 10% .25W FC TC=-400/+600	01121	CB6811
A4R2	2100-2489	9	1	RESISTOR-TRMR 5K 10% C SIDE-ADJ 1-TRN	30983	ET50X502
A4R3	0757-0844	5	1	RESISTOR 16.2K 1% .5W F TC=0+-100	28480	0757-0844
A4R4	0684-1011	5	6	RESISTOR 100 10% .25W FC TC=-400/+500	01121	CB1011
A4R5	0757-0442	9	2	RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1002-F
A4R6	0757-0775	1	2	RESISTOR 90.9K 1% .25W F TC=0+-100	24546	C5-1/4-TO-9092-F
A4R7	0757-0726	2	2	RESISTOR 511 1% .25W F TC=0+-100	24546	C5-1/4-TO-511R-F
A4R8	0757-0735	3	2	RESISTOR 1.3K 1% .25W F TC=0+-100	24546	C5-1/4-TO-1301-F
A4R9	0757-0190	4	3	RESISTOR 20K 1% .5W F TC=0+-100	28480	0757-0190
A4R10	0684-1011	5		RESISTOR 100 10% .25W FC TC=-400/+500	01121	CB1011
A4R11	0757-0190	4		RESISTOR 20K 1% .5W F TC=0+-100	28480	0757-0190
A4R12	0684-1011	5		RESISTOR 100 10% .25W FC TC=-400/+500	01121	CB1011
A4R13	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1002-F

Table 6-2. Replaceable Parts (Cont'd)

Reference Designator	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A4R14	0757-0775	1		RESISTOR 90.0K 1% .25W F TC=0+-100	24546	C5-1/4-TO-9092-F
A4R15	0757-0728	2		RESISTOR 511 1% .25W F TC=0+-100	24546	C5-1/4-TO-511R-F
A4R16	0757-0735	3		RESISTOR 1.3K 1% .25W F TC=0+-100	24546	C5-1/4-TO-1301-F
A4R17	0757-0190	4		RESISTOR 20K 1% .5W F TC=0+-100	28480	0757-0190
A4R18	0684-1011	5		RESISTOR 100 10% .25W FC TC=-400/+500	01121	CB1011
A4R19	0757-0486	1	1	RESISTOR 750K 1% .125W F TC=0+-100	28480	0757-0486
A4R20	2100-3357	2	3	RESISTOR-TRMR 500K 10% C SIDE-ADJ 1-TRN	28480	2100-3357
A4R21	0757-0465	6	2	RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1003-F
A4R22	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1003-F
A4R23	0683-2265	1	1	RESISTOR 22M 5% .25W FC TC=-900/+1200	01121	CB2265
A4R24	0684-4731	2	1	RESISTOR 47K 10% .25W FC TC=-400/+800	01121	CB4731
A4R25	0684-1011	5		RESISTOR 100 10% .25W FC TC=-400/+500	01121	CB1011
A4R26	0683-3915	0	1	RESISTOR 390 5% .25W FC TC=-400/+600	01121	CB3915
A4R27	0684-2221	1	1	RESISTOR 2.2K 10% .25W FC TC=-400/+700	01121	CB2221
A4R28	0684-1021	7	1	RESISTOR 1K 10% .25W FC TC=-400/+600	01121	CB1021
A4R29	0687-3941	0	1	RESISTOR 390K 10% .5W CC TC=0+882	01121	EB3941
A4R30	0684-6811	3		RESISTOR 680 10% .25W FC TC=-400/+600	01121	CB6811
A4R31	0684-6811	3		RESISTOR 680 10% .25W FC TC=-400/+600	01121	CB6811
A4R32	0684-5621	1	1	RESISTOR 5.6K 10% .25W FC TC=-400/+700	01121	CB5621
A4R33	0699-0167	1	1	RESISTOR 20M 5% 1W C TC=0+-250	28480	0699-0167
A4R34	0684-6811	3		RESISTOR 680 10% .25W FC TC=-400/+600	01121	CB6811
A4R35	0684-6811	3		RESISTOR 680 10% .25W FC TC=-400/+600	01121	CB6811
A4R36	0684-1061	5	1	RESISTOR 10M 10% .25W FC TC=-900/+1100	01121	CB1061
A4R37	0684-1011	5		RESISTOR 100 10% .25W FC TC=-400/+500	01121	CB1011
A4R38	0757-0449	6	1	RESISTOR 20K 1% .125W F TC=0+-100	24546	C4-1/8-TO-2002-F
A4R39	2100-3357	2		RESISTOR-TRMR 500K 10% C SIDE-ADJ 1-TRN	28480	2100-3357
A4R40	2100-3357	2		RESISTOR-TRMR 500K 10% C SIDE-ADJ 1-TRN	28480	2100-3357
A4R41	0699-1044	5	1	RESISTOR 7.5M 5% 1W C TC=0+-250	28480	0699-1044
A4R42	2100-3358	3	1	RESISTOR-TRMR 1M 20% C SIDE-ADJ 1-TRN	28480	2100-3358
A4R43	0699-0172	8	1	RESISTOR 3M 5% 1W C TC=0+-250	28480	0699-0172
A4R44	0757-0407	6	1	RESISTOR 200 1% .125W F TC=0+-100	24546	C4-1/8-TO-201-F
A4R45	0698-4508	0	2	RESISTOR 78.7K 1% .125W F TC=0+-100	28480	0698-4508
A4R46	0698-4508	0		RESISTOR 78.7K 1% .125W F TC=0+-100	28480	0698-4508
A4T1	01345-61101	4	1	HV TRANSFORMER	28480	01345-61101
A4TP1	0360-0535	0	2	TERMINAL-TEST POINT PCB	28480	0360-0535
A4TP2	0360-0535	0		TERMINAL-TEST POINT PCB	28480	0360-0535
A4U1	1826-0167	3	1	IC OP AMP PRGMBL TO-99 PKG	01928	CA3094AT
A4V1	2140-0018	0	2	LAMP-GLOW A9A-CT 90VDC 700UA T-2-BULB	0046G	A9A-CT
A4V2	2140-0018	0		LAMP-GLOW A9A-CT 90VDC 700UA T-2-BULB	0046G	A9A-CT
A4VR1	1902-0049	2	1	DIODE-ZNR 6.19V 5% DO-35 PD=.4W	28480	1902-0049
A4VR2	1902-3104	6	1	DIODE-ZNR 5.62V 5% DO-35 PD=.4W	28480	1902-3104
A4VR3	1902-3354	8	1	DIODE-ZNR 54.9V 5% DO-7 PD=.4W TC=+.081%	28480	1902-3354

Table 6-2. Replaceable Parts (Cont'd)

Reference Designator	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A5	01345-66528	9	1	BOARD ASSY-MEMORY	28480	01345-66528
A5C1	0160-5471	9	1	CAPACITOR-FXD .1UF +-5% 50VDC MET-POLYE	28480	0160-5471
A5C2	0160-5298	8	31	CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-5298
A5C3				NOT ASSIGNED		
A5C4				NOT ASSIGNED		
A5C5	0180-0374	3	1	CAPACITOR-FXD 10UF +-10% 20VDC TA	28480	0180-0374
A5C6	0160-5298	8		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-5298
A5C7	0160-5298	8		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-5298
A5C8	0160-5298	8		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-5298
A5C9	0160-5298	8		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-5298
A5C10	0160-5298	8		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-5298
A5C11	0160-5298	8		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-5298
A5C12	0160-5298	8		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-5298
A5C13	0160-5298	8		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-5298
A5C14	0160-5298	8		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-5298
A5C15	0160-5298	8		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-5298
A5C16	0160-5298	8		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-5298
A5C17	0160-5298	8		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-5298
A5C18	0160-5298	8		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-5298
A5C19	0160-5298	8		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-5298
A5C20	0160-5298	8		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-5298
A5C21	0160-5298	8		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-5298
A5C22	0160-5298	8		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-5298
A5C23	0160-5298	8		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-5298
A5C24	0160-5298	8		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-5298
A5C25	0160-5298	8		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-5298
A5C26	0160-5298	8		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-5298
A5C27	0160-5298	8		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-5298
A5C28	0160-5298	8		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-5298
A5C29	0160-5298	8		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-5298
A5C30	0160-5298	8		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-5298
A5C31	0160-5298	8		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-5298
A5C32	0160-5298	8		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-5298
A5C33	0160-5298	8		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-5298
A5C34	0160-5298	8		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-5298
A5C35	0160-5298	8		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-5298
A5E1	1258-0124	7	1	SHUNT-PROGRAMMABLE 1 DBL PIN SET .100	28480	1258-0124
A5J1				NOT ASSIGNED		
A5J2	1251-3976	9	1	CONN-POST TYPE 2.5-PIN-SPCG 6-CONT	28480	1251-3976
A5J3	1251-4836	2	1	CONN-POST TYPE 2.5-PIN-SPCG 2-CONT	28480	1258-4836
A5R1	0757-0442	9	1	RESISTOR 10K 1% .125W F TC=0+-100	24546	CT4-1/8-TO-1002-F
A5R2	0757-0467	8	1	RESISTOR 121K 1% .125W F TC=0+-100	24546	CT4-1/8-TO-1213-F
A5R3				NOT ASSIGNED		
A5R4	0757-0280	3	3	RESISTOR 1K 1% .125W F TC=0+-100	24546	CT4-1/8-TO-1001-F
A5R5	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	CT4-1/8-TO-1001-F
A5R6	8159-0005	0	3	RESISTOR-ZERO OHMS 22 AWG LEAD DIA	28480	8159-0005
A5R7	8159-0005	0		RESISTOR-ZERO OHMS 22 AWG LEAD DIA	28480	8159-0005
A5R8	8159-0005	0		RESISTOR-ZERO OHMS 22 AWG LEAD DIA	28480	8159-0005
A5R9	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	CT4-1/8-TO-1001-F
A5U1	1820-2654	5	4	IC MUXR/DATA-SEL TTL F 2-TO-1-LINE QUAD	07263	74F157PC
A5U2	1820-2779	5	8	IC CNTR TTL ALS BIN SYNCHRO	01295	SN74ALS163AN
A5U3	1820-2779	5		IC CNTR TTL ALS BIN SYNCHRO	01295	SN74ALS163AN
A5U4	1820-2654	5		IC MUXR/DATA-SEL TTL F 2-TO-1-LINE QUAD	07263	74F157PC
A5U5	1820-2779	5		IC CNTR TTL ALS BIN SYNCHRO	01295	SN74ALS163AN
A5U6	1820-2779	5		IC CNTR TTL ALS BIN SYNCHRO	01295	SN74ALS163AN
A5U7				NOT ASSIGNED		
A5U8				NOT ASSIGNED		
A5U9	1818-3336	7	4	IC NMOS 16384 (16K) STAT RAM 45-NS 3-S	04713	MCM2016H-45
A5U10	1818-3336	7		IC NMOS 16384 (16K) STAT RAM 45-NS 3-S	04713	MCM2016H-45
A5U11	1820-3294	1	6	IC FF TTL ALS D-TYPE POS-EDGE-TRIG COM	01295	SN74ALS374N
A5U12	1820-3294	1		IC FF TTL ALS D-TYPE POS-EDGE-TRIG COM	01295	SN74ALS374N
A5U13	1820-3294	1		IC FF TTL ALS D-TYPE POS-EDGE-TRIG COM	01295	SN74ALS374N
A5U14	1820-1416	5	2	IC SCHMITT-TRIG TTL LS INV HEX 1-INP	01295	SN74LS14N
A5U15	01345-80002	4	1	IC PAL 20R8A PMGD	28480	01345-80002
A5U16	01345-80001	3	1	IC PAL 20R8A PMGD	28480	01345-80001
A5U17	1820-2692	1	1	IC GATE TTL F EXCL-OR QUAD 2-INP	07263	74F86PC
A5U18	1820-3220	3	1	IC DCDR TTL F BIN 2-TO-4-LINE DUAL	07263	74F139PC
A5U19	1820-2654	5		IC MUXR/DATA-SEL TTL F 2-TO-1-LINE QUAD	07263	74F157PC
A5U20	1820-2779	5		IC CNTR TTL ALS BIN SYNCHRO	01295	SN74ALS163AN
A5U21	1820-2779	5		IC CNTR TTL ALS BIN SYNCHRO	01295	SN74ALS163AN
A5U22	1820-2654	5		IC MUXR/DATA-SEL TTL F 2-TO-1-LINE QUAD	07263	74F157PC

5-15. STROKE INTENSITY ADJUSTMENT.

Reference:
Service Sheet 3B.

Description:
This procedure describes the adjustments necessary to ensure equal intensity of all vectors.

Equipment Required:
Power Supply
Power Connector (Option 325)

Procedure:
a. Turn on power and obtain primary test pattern on screen.

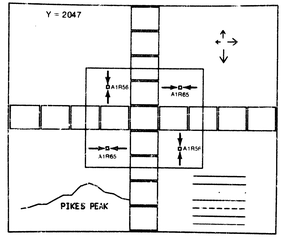


Figure 5-9. Stroke Intensity Adjustment

b. Adjust A1R56 so that the horizontal lines of the four small boxes in the test pattern are of equal intensity (see figure 5-9).

c. Adjust A1R65 so that the vertical lines of the four small boxes in the test pattern are of equal intensity.

Table 5-6. Stroke Intensity Adjustments

Reference Designator	Adjustment Name	Adjustment Paragraph	Service Sheet	Description
A1R56	X-CURRENT OFFSET	5-15,b	3B	Equal intensity of horizontal lines of four small boxes in the test pattern (figure 5-9).
A1R65	Y-CURRENT OFFSET	5-15,c	3B	Equal intensity of vertical lines of four small boxes in the test pattern (figure 5-9).

5-16. FOCUS ADJUSTMENT AND RESOLUTION CHECK.

Reference:
Service Sheets 3C, 5.

Description:
These procedures provide the necessary adjustments for optimum focus of the display. To obtain an accurate resolution check, follow the steps in the same sequence as described below. The Focus Adjustment and Resolution Check consists of three parts.
1. Adjusting the Z-Axis Drive to +40 V.
2. Adjusting Focus using the Secondary Test Pattern.
3. Verify Resolution using the Secondary Test Pattern.

Equipment Required:
Power Supply
Power Connector (Option 325)
Oscilloscope
10:1 Divider Probe

Procedure:
1. Adjusting Z-Axis Drive to +40 V.

a. Disconnect I/O Port and apply power to the 1345A. The Primary Test Pattern should be displayed.

b. Monitor Test Point A4TP2 with an oscilloscope.

c. Set oscilloscope sweep speed to 2 milliseconds/div and vertical attenuator to 1 V/div. Use a 10:1 divider probe to obtain a 10 V/div deflection factor.

d. Turn Intensity Control (A1R129) fully counterclockwise.

e. Adjust Intensity Cut-off Level (A1R131) so that the dot, over the Y=2047 in the pattern, is just extinguished. Shade the CRT face to make sure that the dot is not visible.

f. Disregarding overshoot, adjust Intensity Control (A1R129) for a +40 V p-p waveform. If +40 V cannot be obtained, set Intensity Control fully clockwise.

2. Focus Adjustment Procedure.

a. Short the Pins of A2J6 together to display the Secondary Test Pattern.

b. Monitor Test Point A1TP10 with an oscilloscope and note the DC voltage (approximately 7.0 V). In making this measurement, DC couple the oscilloscope's vertical attenuator.

c. Monitor Test Point A1TP9 and adjust Y-Offset, A1R138, so that the baseline of the monitored signal is at the same DC level as noted in step b.

d. Connect oscilloscope to Test Point A1TP11 and adjust X-Offset A1R135, until the baseline of the monitored signal is at the same DC level as in step b.

e. Using a 10:1 divider probe to obtain a 10 V/div deflection factor, set oscilloscope attenuator to 1 V/div, DC coupled and sweep speed to 5 milliseconds/div. Monitor Test Point A4TP1 and adjust Fine Focus, A1R149, so that the baseline of displayed signal is at +50 V.

f. Adjust Focus, A4R42, for optimum focus of displayed pattern.

g. Turn Intensity Control, A1R129, over its range of adjustment. The display should stay focused. If not, adjust Focus Gain A4R2 until pattern stays focused over the entire intensity range.

h. Adjust X-Gain, A1R142, for best focus at left and right edges of the pattern.

i. Adjust Y-Gain, A1R145, for best focus at top and bottom edges of the pattern. Steps h and i are interactive, therefore repeat those steps until optimum focus of all edges of the pattern is achieved.

j. Compare the pattern on screen with that shown in figure 5-10.

3. Checking CRT Resolution.

a. Ensure that all the Z-Axis Drive and Focus adjustments have been performed.

b. A 1345A passes the Resolution Test if all of the individual lines in all 13 boxes of the pattern can be resolved. If the Resolution Test fails, repeat the Z-Axis Drive Adjustment and the Focus Adjustment Procedures. If the Resolution Test fails again, contact the Colorado Springs Division or your nearest Sales and Service Office for additional assistance.

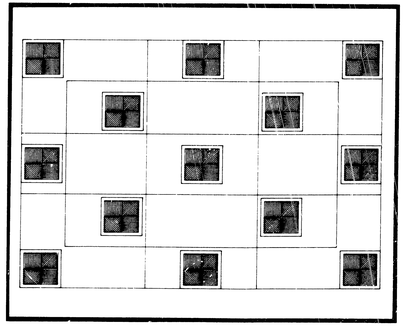
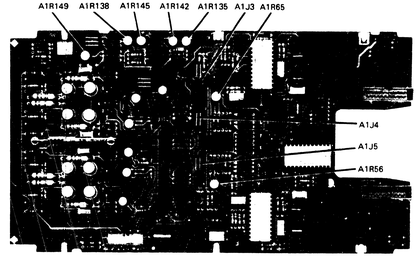


Figure 5-10. Test Pattern for Focus Adjustment



NOTE: A4R2 AND A4R42 ARE LOCATED ON FIGURE 5-3

1345-81-075

Figure 5-11. Stroke Intensity and Focus Adjustment Locations

Table 5-7. Z-Axis Drive and Focus Adjustments

Reference Designator	Adjustment Name	Adjustment Paragraph	Service Sheet	Description
A1R131	INTENSITY CUT OFF LEVEL	5-16,e	3C	Adjust so that dot over Y=2047 in pattern is extinguished.
A1R129	INTENSITY CONTROL	5-16,f	3C	Adjust for a +40 V p-p waveform.
A1R138	Y-FOCUS OFFSET	5-16,d	3C	Monitor at A1TP9, adjust for a DC level as in step c (approx +7 V).
A1R135	X-FOCUS OFFSET	5-16,e	3C	Monitor at A1TP11,adjust for a DC level as in step c (approx +7 V).
A1R149	FOCUS FINE ADJUST	5-16,f	3C	Monitor at A4TP1, adjust for a baseline level of +50 V.
A4R42	FOCUS	5-16,g	5	Adjust for optimum focused test pattern.
A4R2	FOCUS GAIN	5-16,h	5	Adjust so that pattern stays focused over intensity range (A1R129).
A1R142	X-FOCUS GAIN	5-16,j	3C	Optimum focus of right and left edges of the secondary test pattern (figure 5-10).
A1R145	Y-FOCUS GAIN	5-16,k	3C	Optimum focus of top and bottom of the secondary test pattern (figure 5-10).

Table 6-2. Replaceable Parts (Cont'd)

Reference Designator	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A5U23	1820-2779	5		IC CNTR TTL ALS BIN SYNCHRO	01295	SN74ALS163AN
A5U24	1820-2779	5		IC CNTR TTL ALS BIN SYNCHRO	01295	SN74ALS163AN
A5U25	1826-0180	0	1	IC TIMER TTL MONO/ASTBL	01295	NE555P
A5U26	1820-2488	3	2	IC FF TTL ALS D-TYPE POS-EDGE-TRIG	01295	SN74ALS74N
A5U27	1820-2656	7	2	IC GATE TTL ALS NAND QUAD 2-INP	01295	SN74ALS00AN
A5U28	1820-2488	3		IC FF TTL ALS D-TYPE POS-EDGE-TRIG	01295	SN74ALS74N
A5U29	1820-1645	2	1	IC BFR TTL LS BUS QUAD	01295	SN74LS126AN
A5U30				NOT ASSIGNED		
A5U31				NOT ASSIGNED		
A5U32	1818-3336	7		IC NMOS 16384 (16K) STAT RAM 45-NS 3-S	04713	MCM2016H-45
A5U33	1818-3336	7		IC NMOS 16384 (16K) STAT RAM 45-NS 3-S	04713	MCM2016H-45
A5U34	1820-3294	1		IC FF TTL ALS D-TYPE POS-EDGE-TRIG COM	01295	SN74ALS374N
A5U35	1820-3294	1		IC FF TTL ALS D-TYPE POS-EDGE-TRIG COM	01295	SN74ALS374N
A5U36	1820-3294	1		IC FF TTL ALS D-TYPE POS-EDGE-TRIG COM	01295	SN74ALS374N
A5U37	1820-1416	5		IC SCHMITT-TRIG TTL LS INV HEX 1-INP	01295	SN74LS14N
A5U38	1820-2656	7		IC GATE TTL ALS NAND QUAD 2-INP	01295	SN74ALS00AN
A5U39	1820-2701	3	1	IC FF TTL F D-TYPE POS-EDGE-TRIG COM	07263	74F374PC
A5W1	01345-61625	7	1	CABLE ASSY VPC-MGM	28480	01345-61625
A5W2	01345-61606	4	1	CABLE ASSY-POWER	28480	01345-61606
A5XU15	1200-1174	8	2	SOCKET IC 24-CONT DIP DIP-SLDR	28480	1200-1174
A5XU16	1200-1174	8		SOCKET IC 24-CONT DIP DIP-SLDR	28480	1200-1174
A5Y1	1813-0126	7	1	XTAL-CLOCK-OSCILLATOR 22.2464-MHZ 0.10%	28480	1813-0126

Table 6-3. List of Manufacturers' Codes

Mfr No.	Manufacturer Name	Address		Zip Code
00000	ANY SATISFACTORY SUPPLIER			
01121	ALLEN-BRADLEY CO	MILWAUKEE	WI	53204
01281	TRW INC SEMICONDUCTOR DIV	LAWNDALE	CA	90260
01295	TEXAS INSTR INC SEMICOND CMPNT DIV	DALLAS	TX	75222
01928	RCA CORP SOLID STATE DIV	SOMERVILLE	NJ	08876
02111	SPECTROL ELECTRONICS CORP	CITY OF IND	CA	91745
03508	GE CO SEMICONDUCTOR PROD DEPT	SYRACUSE	NY	13201
03888	KDI PYROFILM CORP	WHIPPANY	NJ	07981
04713	MOTOROLA SEMICONDUCTOR PRODUCTS	PHOENIX	AZ	85008
06383	PANDUIT CORP	TINLEY PK	IL	60477
08665	PRECISION MONOLITHICS INC	SANTA CLARA	CA	95050
07263	FAIRCHILD SEMICONDUCTOR DIV	MOUNTAIN VIEW	CA	94042
18546	VARO SEMICONDUCTOR INC	GARLAND	TX	75040
11236	CTS OF BERNE INC	BERNE	IN	46711
11502	TRW INC	BOONE DIV	NC	28607
13606	SPRAGUE ELECTRIC CO TRANSISTOR DIV	CONCORD	NH	03301
14433	ITT SEMICONDUCTORS DIV	WEST PALM BEACH	FL	
15454	AMETEK/RODAN DIV	ANAHEIM	CA	92806
19701	MEPCO/ELECTRA CORP	MINERAL WELLS	TX	76067
24046	TRANSITRON ELECTRONIC CORP	WAKEFIELD	MA	01880
24546	CORNING GLASS WORKS (BRADFORD)	BRADFORD	PA	16701
25403	N.V. PHILIPS-ELCOMA DEPARTMENT	EINDHOVEN	HL	02876
27014	NATIONAL SEMICONDUCTOR CORP	PALO ALTO	CA	94304
27167	CORNING GLASS WORKS (WILMINGTON)	WILMINGTON	NC	28401
28480	HEWLETT-PACKARD CO CORPORATE HQ	PALO ALTO	CA	94304
3L585	RCA CORP SOLID STATE DIV	SOMERVILLE	NJ	
30983	MEPCO/ELECTRA CORP	SAN DIEGO	CA	92121
32997	BOURNS INC TRIMPOT PROD DIV	RIVERSIDE	CA	92507
34335	ADVANCED MICRO DEVICES INC	SUNNYVALE	CA	94086
34371	HARRIS SEMICON DIV	MELBOURNE	FL	32901
34649	INTEL CORP	MOUNTAIN VIEW	CA	95051
50088	MOSTEK CORP	CARROLLTON	TX	75006
52763	STETTNER ELECTRONICS INC	CHATTANOOGA	TN	13035
56289	SPRAGUE ELECTRIC CO	NORTH ADAMS	MA	01247
72136	ELECTRO MOTIVE CORP	FLORENCE	SC	06226
72982	ERIE TECHNOLOGICAL PRODUCTS INC	ERIE	PA	16512
73138	BECKMAN INSTRUMENTS INC HELIPOT DIV	FULLERTON	CA	92634
74100	BUSSMAN MFG DIV OF MCGRAW-EDISON CO	ST LOUIS	MO	63107
75915	LITTELFUSE INC	DES PLAINES	IL	60016
84411	TRW CAPACITOR DIV	OGALLALA	NE	69153
91506	AUGUT INC	ATTLEBORO	MA	02703

SECTION VII

MANUAL CHANGES

7-1. INTRODUCTION.

7-2. This section contains information for adapting this manual to instruments for which the content does not apply directly.

7-3. MANUAL CHANGES.

7-4. To adapt this manual to your instrument, refer to table 7-1 and make all manual changes listed for your instrument serial prefix number. Perform these changes in the sequence listed. If your instrument serial prefix number is not listed on the title page or in table 7-1, it may be documented in a yellow MANUAL CHANGE supplement. For additional information about serial number coverage, refer to INSTRUMENTS COVERED BY MANUAL in Section I.

Table 7-1. Manual Changes by Serial Prefix Number

Serial Prefix Number	Make Manual Changes
2112A	7,6,5,4,3,2,1
2227A	7,6,5,4,3,2
2250A	7,6,5,4,3
2331A	7,6,5,4
2335A	7,6,5
2411A	7,6
2501A	7

7-5. MANUAL CHANGE INSTRUCTIONS.

CHANGE 1

SECTION VI. REPLACEABLE PARTS,
Table 6-2. Replaceable Parts,
Change: A5 (MEMORY OPTION BOARD) HP and Mfr Part Nos. to 01345-66506 (2 places)
Change: A5C4 (CAPACITOR 36PF, MI 300V) HP and Mfr Part Nos. to 0160-2308.
Delete: A5C33
Change: A5U4 (IC, MONOSTBL TTL) HP and Mfr Part Nos. to 1820-1423.

SECTION VIII. SERVICE,
Service Sheet 6. Memory Option 704,
Change value of A5C4 from 51PF to 36PF.
Delete A5C33.

CHANGE 2

SECTION I. GENERAL INFORMATION,
Table 1-2. 1345A Functions,
Line Types:,
Delete: Dots at end points only.
SECTION III. OPERATION,
Paragraph 3-9. INSTRUCTIONS.
Replace: Sub-paragraph 1. Set Condition Command
Sub-paragraph 2. Plot Command
Sub-paragraph 3. Graph Command
Sub-paragraph 4. Text Command
with: Pages 7-5 and 7-6 of this section.
SECTION VI. REPLACEABLE PARTS,
Table 6-2. Replaceable Parts,
Change: A1 (PC BOARD X-Y/STR GEN) HP and Mfr Part Nos. to 01345-66501 (2 places).
Change: A2 (PC BOARD-VECT PROCESSOR) HP and Mfr Part Nos. to 01345-66502 (2 places).
Change: A3 (PC BOARD-LOW VOLTAGE POWER SUPPLY) HP and Mfr Part Nos. to 01345-66503 (2 places).
Change: MP7 (LABEL-CAL) HP and Mfr Part Nos. to 7140-2140.
Change: MP11 (PANEL-REAR) HP and Mfr Part Nos. to 01345-00201.
Delete: A1E11.
Delete: A1J9.
Delete: A1J10.
Delete: A1R161
Delete: A1R162
Change: A1U30 (IC V RGLTR) HP and Mfr Part Nos. to 1826-0214.
Delete: A1VR8
Delete: A1VR9
Delete: A1VR10
Delete: A1VR11
Change: A2U1(IC 8748) HP and Mfr Part Nos. to 1820-2663.
Change: A2U12 (IC NMOS 16K ROM) HP and Mfr Part Nos. to 1818-1632.
Delete: A2U27
Change: A3F1 (FUSE 1.5AT) HP and Mfr Part Nos. to 2110-0304.
Change: A3F2 (FUSE 3.0AT) HP and Mfr Part Nos. to 2110-0029.
Change: A3F3 (FUSE .5A) HP and Mfr Part Nos. to 2110-0012.
SECTION VIII. SERVICE,
Replace pages 8-5 through 8-12 with pages 7-7 through 7-12 of this section.
Service Sheet 4. Low Voltage Power Supply,
Change current rating of A3F1 to 1.5A.
Change current rating of A3F2 to 3.0A.
Change current rating of A3F3 to 0.5A.

CHANGE 3

SECTION V. ADJUSTMENTS,
Replace pages 5-7 and 5-8 with pages 7-13 and 7-14 of this section.

SECTION VI. REPLACEABLE PARTS,
Table 6-2. Replaceable Parts,
Change: A1 (BOARD-XY/STR GEN) HP and Mfr Part Nos. to 01345-66510 (2 places).

NOTE: 01345-66510 HAS BEEN OBSOLETED AND DIRECTLY REPLACED BY 01345-66518.

Change: A2 (BOARD-VECT PROC) HP and Mfr Part Nos. to 01345-66514 (2 places).

NOTE: 01345-66514 HAS BEEN OBSOLETED AND DIRECTLY REPLACED BY 01345-66519.

Change: A1R24 to (RESISTOR 511 1% .125W FTC=0±100)HP and Mfr Part Nos. 0757-0416.
Add: A1C15 (CAPACITOR-FXD 68PF ±5% 300VDC MICA) HP Part No. 0140-0192, Mfr Part No. DM15E680J0300WV1CR, Mfr Code 72136.
Add: A1C25 (CAPACITOR-FXD 68PF ±5% 300VDC MICA) HP Part No. 0140-0192, Mfr Part No. DM15E680J0300WV1CR, Mfr Code 72136.
Add: A1R89 (RESISTOR 147 1% .125W F TC=0±100) HP Part No. 0698-3438, Mfr Part No. C4-1/8-TO-147R-F, Mfr Code 24546.
Add: A1R112 (RESISTOR 147 1% .125W F TC=0±100) HI Part No. 0698-3438, Mfr Part No. C4-1/8-TO-147R-F, Mfr Code 24546.
Delete: A1C54.
Delete: A1C55.
Delete: A1J11.
Delete: A1J12.
Delete: A1R163.
Delete: A1R164.
Delete: A1R165.
Delete: A1R166.
Delete: A1R167.
Delete: A1R168.
Change: A2U1 (SELF TEST μP) HP and Mfr Part Nos. to 01347-80004.

NOTE: 01347-80004 HAS BEEN OBSOLETED AND DIRECTLY REPLACED BY 01347-80010.

SECTION VIII. SERVICE,
Service Sheet 3A. X-Y-Z Amp/Stroke Generator (A1),
Change value of A1R24 from 475 ohms to 511 ohms.

Service Sheet 3C. X-Y-Z Amp/Stroke Generator (A1),
Replace pages 8-13 through 8-16 with pages 7-15 through 7-18 of this section.

CHANGE 4

SECTION VI. REPLACEABLE PARTS,
Table 6-2. Replaceable Parts,
Change: V1 (CRT P31) HP and Mfr Part Nos. to 5083-6251.

NOTE: 5083-6251 HAS BEEN OBSOLETED AND DIRECTLY REPLACED BY 5083-6451.

CHANGE 5

SECTION VI. REPLACEABLE PARTS,
Table 6-2. Replaceable Parts,
Change: A4 (BOARD ASSY-HIGH VOLTAGE) HP and Mfr Part Nos. to 01345-66504 (2 places).

NOTE: 01345-66504 HAS BEEN OBSOLETED AND DIRECTLY REPLACED BY 01345-66523.

Change: A4C3 to (CAPACITOR-FXD .01UF +80-20% 100VDC CER) HP and Mfr Part Nos. 0160-2055.
Change: A4C6 to (CAPACITOR-FXD .01UF +80-20% 100VDC CER) HP and Mfr Part Nos. 0160-2055.
Delete: A4C23
Delete: A4C24
Delete: A4J11
Delete: A4R44
Delete: A4R45
Delete: A4R46

SECTION VIII. SERVICE,
Service Sheet 5. High Voltage Power Supply,
Delete: A4C23
Delete: A4C24
Delete: A4J11
Delete: A4R44
Delete: A4R45
Delete: A4R46

CHANGE 6

SECTION VI. REPLACEABLE PARTS,
Table 6-2. Replaceable Parts,
Change: A5 (MEMORY OPTION BOARD) HP and Mfr Part Nos. to 01345-66511 (2 places).

NOTE: 01345-66511 HAS BEEN OBSOLETED AND DIRECTLY REPLACED BY 01345-66525.

Change: A5W1 (DATA CABLE) HP and Mfr Part Nos. to 01345-61603.
Change: A5C33 (CAPACITOR-FXD 150PF ±5% 100VDC MICA) HP and Mfr Part Nos. to 0160-4814.

SECTION VIII. SERVICE,
Service Sheet 6. Memory Option 704,
Replace pages 8-21 and 8-22 with pages 7-19 and 7-20 of this section.

CHANGE 7

SECTION I. GENERAL INFORMATION;
SECTION II. INSTALLATION;
SECTION III OPERATION.
The information contained in Sections I, II, and III applies to all serial prefixes 2515A and below. Information from the Designers Manual HP Part No. 01345-90902 has been incorporated into these sections. The Designers Manual HP Part No. 01345-90902 is now obsolete.

SECTION VI. REPLACEABLE PARTS,
Table 6-2, Replaceable Parts,
Change: A1 (BOARD-XY/STR GEN) HP and MfrPart Nos. to 01345-66518 (2 places).
Change: A2 (BOARD-VECT PROC) HP and Mfr Part Nos. to 01345-66519 (2 places).
Change: A5 (MEMORY OPTION BOARD) HP and Mfr Part Nos. to 01345-66525 (2 places).

NOTE: MEMORY OPTION BOARDS 01345-66511 AND 01345-66506 HAVE BEEN OBSOLETED AND DIRECTLY REPLACED BY 01345-66525. IF MEMORY OPTION BOARD 01345-66528 IS INSTALLED, VECTOR PROCESSOR BOARD (A2) 01345-66527 MUST ALSO BE INSTALLED TO ENSURE PROPER OPERATION.

Change: A1C12, A1C13, A1C22, A1C23, A1C32, A1C33, A1C50, A1C51, A1C52, A1C53 to (CAPACITOR-FXD .1UF +80-20% 50VDC CER); HP and Mfr Part Nos. 0160-3443; CD 1.
Change: A1C18 QTY to 18.
Change: A1C17, A1C20, A1C27, A1C30, A1C54, A1C55 to (CAPACITOR-FXD .01UF +80 20% 100VDC CER); HP and Mfr Part Nos. 0160-2055; CD 9; QTY 6.
Change: A1R20, A1R48 to (RESISTOR-TRMR 20K 10% C SIDE-ADJ 17-TRN); HP and Mfr Part Nos. 2100-3161.
Delete: A1R169.
Replace pages 6-11 and 6-12 with pages 7-21 and 7-22 of this section.
Replace pages 6-15 through 6-18 with pages 7-23 through 7-26 of this section.

SECTION VIII. SERVICE,
Service Sheets 2A and 2B. Vector Processor,
Replace pages 8-7 through 8-10 with pages 7-27 and 7-28 of this section.
Service Sheet 3B. X-Y-Z Amp/Stroke Generator,
Delete R169 from Pin 16 of U25.
Service Sheets 6A and 6B. Memory Option 704,
Replace pages 8-21 through 8-23 with pages 7-29 and 7-30 of this section.

1. Set Condition Command (B14 = 1, B13 = 1).

With both MSBs (Most Significant Bits) set to one, the 1345A is commanded to draw all following vectors according to the configuration commanded until changed by subsequent condition command.

NOTE

A one (1) = TTL high; a zero (0) = TTL low.

The Set Condition command controls the intensity level, the line type, and the writing speed of vectors drawn on the CRT.

B14	B13	B12	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0
1	1	I1	I0	X	X	L1	L0	0	X	W1	W0	X	X	X

* B6 MUST be zero.

X = DON'T CARE

B14=1, B13=1: Set display configuration according to choices specified for intensity, line type, and writing speed.

I1	I0	(Intensity)
0	0	Blank
0	1	Dim
1	0	Half Brightness
1	1	Full Brightness

L1	L0	(Line Type)
0	0	Solid Line
0	1	Intensify Endpoints (solid line)
1	0	Long Dashes
1	1	Short Dashes
0	1	Dots on Endpoints

W1	W0	(Writing Speed)
1	1	0.05 in. per microsecond
1	0	0.10 in. per microsecond
0	1	0.15 in. per microsecond
0	0	0.20 in. per microsecond

When the line type "solid line with intensified endpoints" is selected, the intensity of the endpoints may vary due to optical illusion. As lines are linked together, the intensity of the point where one line ends and the next line starts is a function of the angle separating the lines. The closer the angle is to 180 degrees, the brighter the point. The closer the angle is to zero degrees (absolute), the dimmer the point.

2. Plot Command (B14 = 0, B13 = 0).

With both MSBs set to zero, the 1345A is commanded to move the display beam to a specific X-Y location each time that a Y coordinate is received.

The beam position may be moved with the beam either turned off or on.

The Plot command will draw all vectors according to the display configuration established by the last Set Condition command received by the 1345A.

Each time that a Y coordinate is received the beam status (on or off) for the beam movement is established. Also, the X-Y location to be moved to is formed from the last X coordinate received and the current Y coordinate. For example, to draw a vertical line send the 1345A: (1) Plot Command — X value; (2) Plot Command — Y1 value (with beam off); (3) Plot Command — Y2 value (with beam on).

B14	B13	B12	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0
0	0	XY	PC	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
				DATA										
				MSB										LSB

B14 = 0, B13 = 0: Plot Command.

XY

0 = X coordinate (0-2047) as specified by D0 - D10.
1 = Y coordinate (0-2047) as specified by D0 - D10.

PC (Beam Control Bit)

0 = Move (beam off)
1 = Draw (beam on)

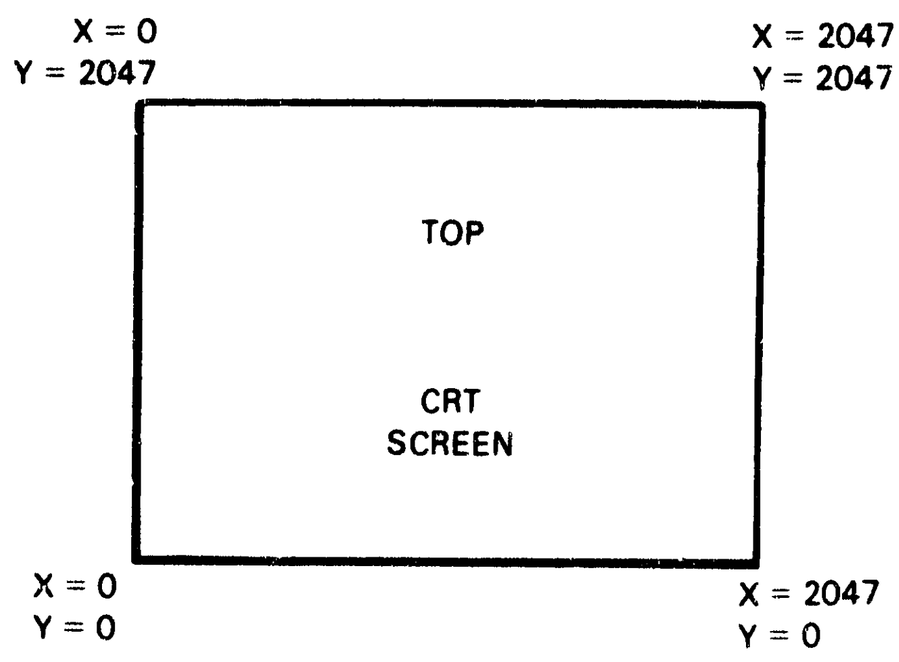


Figure 3-7. Vector Drawing Area

3. Graph Command (B14 = 0, B13 = 1).

With the two MSBs set to zero and one, respectively, the 1345A is commanded to either: (a) set the DELTA-X increment; or (b) move the beam to a specific X-Y location determined by the X increment and the Y coordinate.

The beam position may be moved with the beam either turned off or on. Beam status for the beam movement is established each time that a Y coordinate Graph command is received.

The Graph command will draw all vectors according to the display configuration established by the last Set Condition command received by the 1345A.

B14	B13	B12	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0
0	1	XY	PC	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0

DATA
MSB ——————————— LSB

B14 = 0, B13 = 1: Graph Command.

XY
0 = set automatic DELTA-X increment (as specified by D0 - D10) for all subsequent Y coordinate Graph commands received.
1 = Y coordinate (as specified by D0 - D10) to which the beam is to be moved in conjunction with the DELTA-X increment.

PC (Beam Control Bit)
0 = Move (beam off)
1 = Draw (beam on)

Example:

To graph, first move the beam to a starting position P1 (Plot Commands: X value; Y value with beam off). Then send the 1345A:

1) DELTA-X Graph command.
2) Y1 Graph command with the beam on. This moves the beam to point G1. Note that there is no DELTA-X increment with the first Y Graph command.
3) Y2 Graph command with the beam on. This moves the beam to point G2.
4) Y3 Graph command with the beam on. This moves the beam to point G3.
5) Y4 Graph command with the beam on. This moves the beam to point G4.

This will give a picture as shown below.

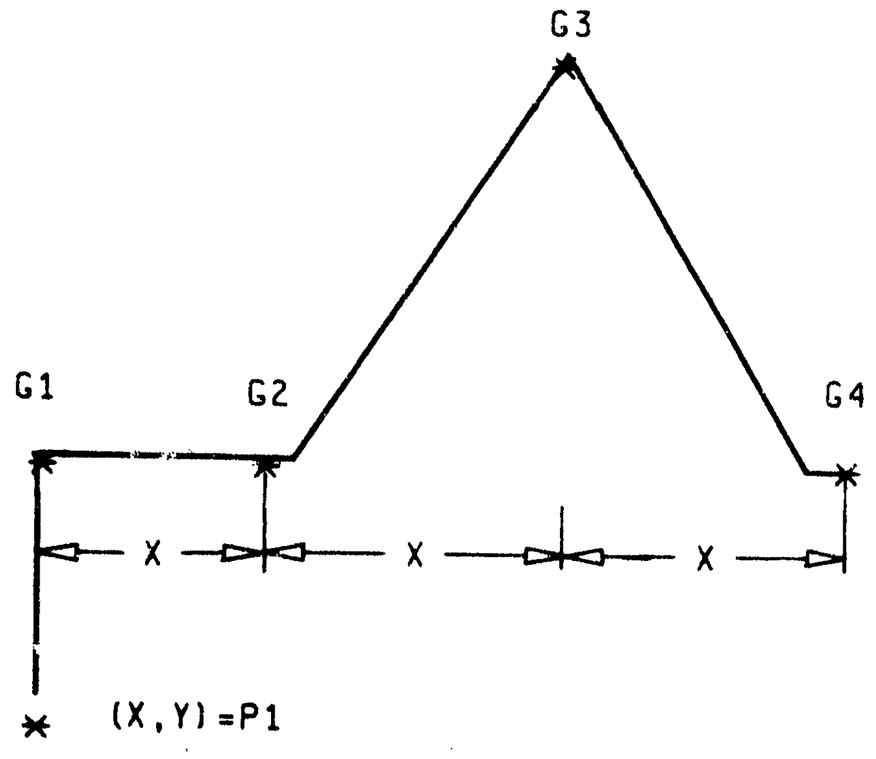


Figure 3-12. Graphing Example

4. Text Command (B14 = 1, B13 = 0).

With the two MSBs set to one and zero, respectively, the 1345A is commanded to draw all the vectors necessary to produce the character specified.

The 1345A automatically provides a space to the right of each character for character spacing.

The Text command will draw the character according to the display configuration established by the last Set Condition command received by the 1345A.

Instead of specifying a character to be drawn, the Text command character code can be replaced by a beam movement control code. These codes that move the beam (with the beam off) are Carriage Return (CR), Line Feed (LF), Inverse Line Feed, Backspace (BS),1/2 shift up, and 1/2 shift down. The amount and direction of beam movement depends on the character size and orientation specified. Line Feed and Inverse Line Feed provide automatic spacing between lines of text (spacing = height of one character between lines).

The starting point for non-rotated characters is the lower left-hand corner of the character area. For rotated characters the entire character area is rotated the specified number of degrees (90, 180, or 270) in a counterclockwise direction around the starting point.

When the 1345A has finished drawing a character it automatically advances the beam to the starting point for the next character. In this way the 1345A functions much like a typewriter when presenting text.

The modified ASCII character set for the 1345A is shown in table 3-1.

B14	B13	B12	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0
1	0	S1	S0	R1	R0	ES	D7	D6	D5	D4	D3	D2	D1	D0

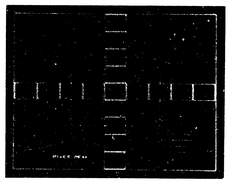
CHARACTER
MSB ——————————— LSB

B14 = 1, B13 = 0: commands that the 1345A display a text character (specified by D0 - D7).

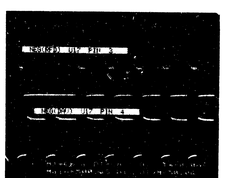
ES (Establish size of character)
0 = use previous size and rotation
1 = establish new size and rotation according to S1-S0 and R1-R0

R1	R0	(Character Rotation (CCW))
0	0	0 degrees
0	1	90 degrees
1	0	180 degrees
1	1	270 degrees

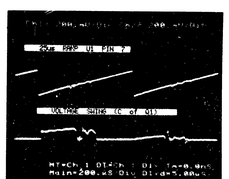
WAVEFORM MEASUREMENT CONDITION



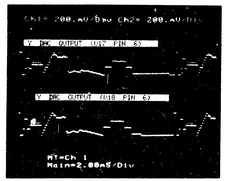
OBTAIN PRIMARY TEST PATTERN AS SHOWN ABOVE



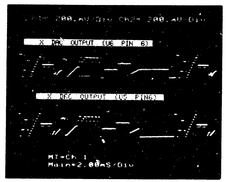
TOP: RFD A2, U17 PIN 3
BOTTOM: DAV A2, U17 PIN 4



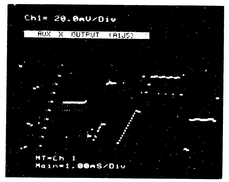
TOP: A4, U1 PIN 7
BOTTOM: A3, Q1 COLLECTOR



TOP: Y DAC OUTPUT A1, U17 PIN 6
BOTTOM: Y DAC OUTPUT A1, U18 PIN 6



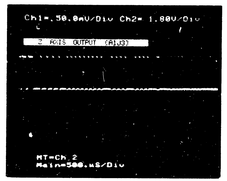
TOP: X DAC OUTPUT A1, U6 PIN 6
BOTTOM: X DAC OUTPUT A1, U5 PIN 6



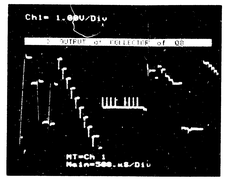
X AUX OUTPUT AT A1J5



Y AUX OUTPUT AT A1J4



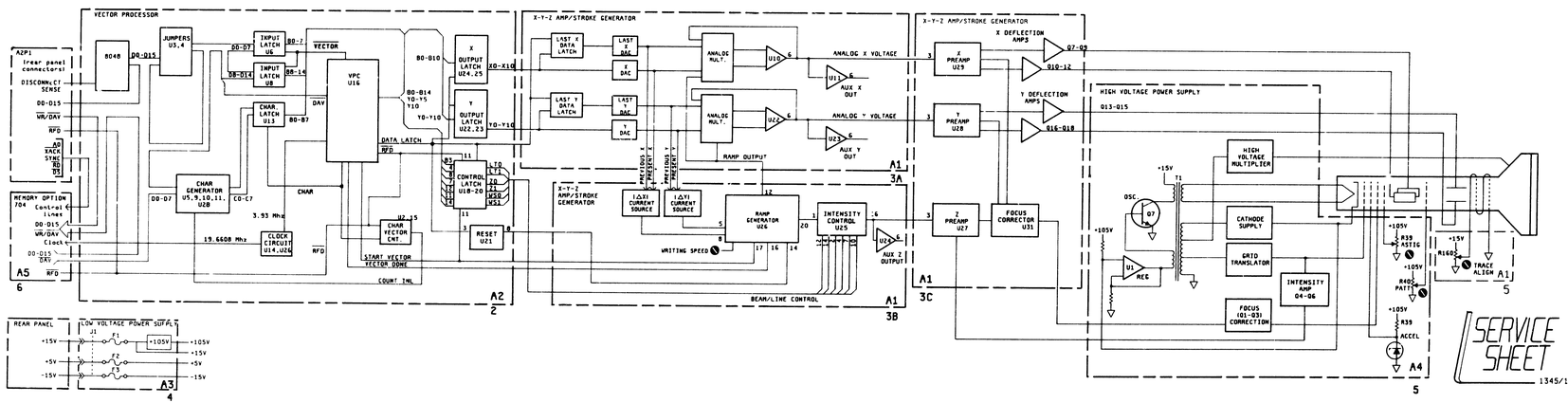
Z AUX OUTPUT AT A1J3



X OUTPUT AT A1 COLLECTOR OF Q8
(TO HORIZONTAL CRT DEFLECTION PLATES)



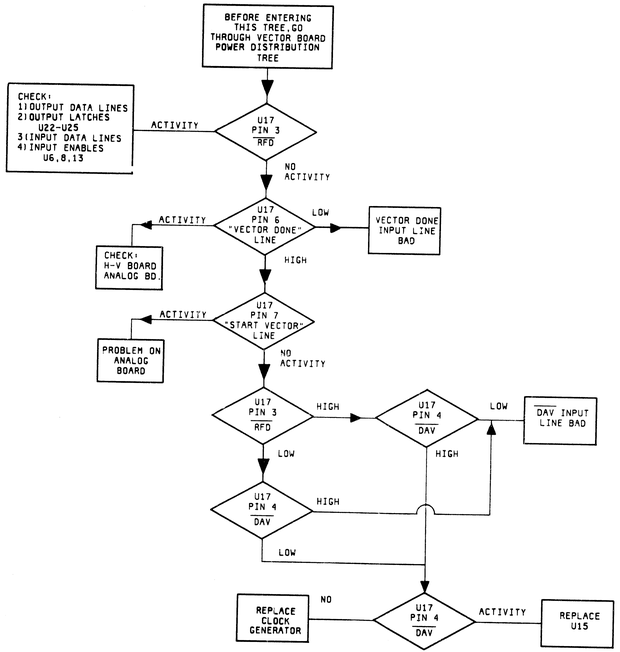
Y OUTPUT AT A1 COLLECTOR OF Q14
(TO VERTICAL CRT DEFLECTION PLATES)



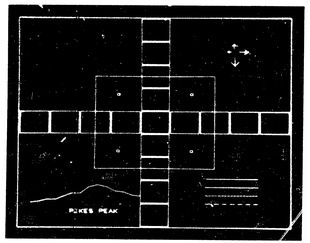
SERVICE SHEET 1

1345/123/CJF/07/08/81

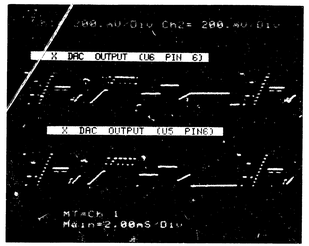
Figure 7-1.
Replacement for Service Sheet 1, Block Diagram



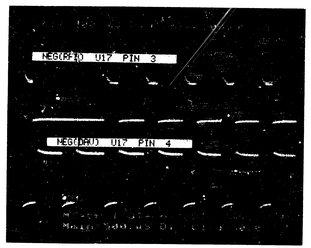
WAVEFORM MEASUREMENT CONDITION



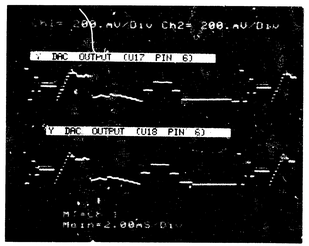
OBTAIN PRIMARY TEST PATTERN AS SHOWN ABOVE



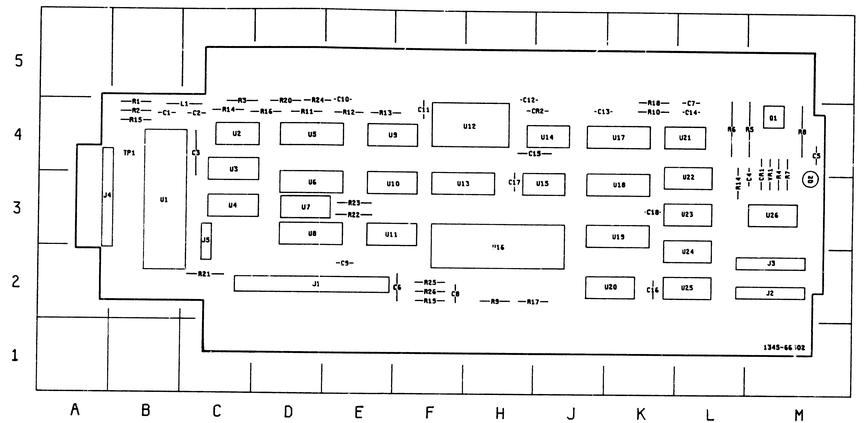
TOP: X DAC OUTPUT A1 U6 PIN 6
BOTTOM: X DAC OUTPUT A1 U5 PIN 6



TOP: $\overline{RFD}$ A2, U17 PIN 3
BOTTOM: $\overline{DAV}$ A2, U17 PIN 4



TOP: Y DAC OUTPUT A1 U17 PIN 6
BOTTOM: Y DAC OUTPUT A1 U18 PIN 6



REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC
C1	B-4	J2	M-2	R15	B-4	U8	D-3
C2	C-4	J3	M-2	R16	D-4	U9	E-2
C3	C-4	J4	A-3	R17	J-2	U10	E-3
C4	M-4	J5	C-3	R18	K-3	U11	E-3
C5	M-4	L1	C-4	R19	F-2	U12	H-4
C6	F-2	Q1	M-4	R20	D-4	U13	F-3
C7	L-4	Q2	M-3	R21	C-2	U14	J-4
C8	F-2	R1	B-4	R22	E-3	U15	J-3
C9	E-2	R2	B-4	R23	E-3	U16	H-2
C10	E-4	R3	C-5	R24	D-4	U17	K-4
C11	F-4	R4	M-4	R25	F-2	U18	K-3
C12	H-5	R5	M-4	R26	F-2	U19	K-3
C13	J-4	R6	L-4	TP1	B-4	U20	K-2
C14	L-4	R7	M-4	U1	B-3	U21	L-4
C15	J-4	R8	M-4	U2	C-4	U22	L-3
C16	K-2	R9	H-2	U3	C-4	U23	L-3
C17	H-3	R10	K-4	U4	C-3	U24	L-2
C18	K-3	R11	D-4	U5	D-4	U25	L-2
CR1	M-4	R12	E-4	U6	D-3	U26	M-3
CR2	J-4	R13	E-4	U7	D-3	VR1	M-4
J1	D-2	R14	C-4				

P/O Service Sheet 2, Vector Processor (A2)

5-17. WRITING RATE ADJUSTMENT.

Reference:
Service Sheet 3B.

Description:
This procedure describes the adjustments for writing speed.

Equipment Required:
Power Supply
Power Connector (Option 325)
Oscilloscope
10:1 Divider Probe

Procedure:
a. Short the Pins of A2J6 together and turn on power to obtain the secondary test pattern on screen.

b. Monitor A1TP12 with the oscilloscope and adjust A1R70 so that the length of the second positive pulse in the frame is 90 μs (+–2 μs) long.

c. Verify that the first pulse in the frame is approximately 117 μs long.

Table 5-8. Writing Rate Adjustment

Reference Designator	Adjustment Name	Adjustment Paragraph	Service Sheet	Description
A1R70	WRITING SPEED	5-17,b	3B	Monitor at A1TP12, adjust for 90 μs length of second positive pulse in the frame.

5-18. ASTIGMATISM AND PATTERN ADJUSTMENT.

Reference:
Service Sheet 4.

Description:
These adjustment procedures are the "fine touch" adjustment for Astigmatism and Pattern.

Equipment Required:
Power Supply
Power Connector (Option 325)

Procedure:
a. Turn on power and display the primary test pattern.

b. Adjust A4R40 for optimum pattern on the outer box of the primary test pattern.

c. Adjust A4R39 so that the astigmatism at the corners of the inner box of the test pattern is optimally adjusted.

Table 5-9. Astigmatism and Pattern Adjustment

Reference Designator	Adjustment Name	Adjustment Paragraph	Service Sheet	Description
A4R40	PATTERN ADJUST	5-18,b	5	Adjust for optimum pattern of the outer box in the primary test pattern.
A4R39	ASTIGMATISM ADJUST	-18,c	5	Adjust for optimum astigmatism at the corners of the inner box in the primary test pattern.

5-19. AUXILIARY X-Y-Z OUTPUT CHECK.

Reference:
Service Sheets 3A, 3B.

Description:
This check verifies the auxiliary X-Y-Z Outputs.

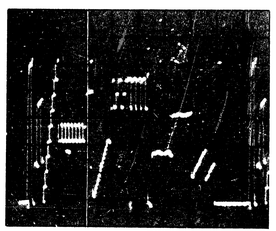
Equipment Required:
Power Supply
Power Connector (Option 325)
Oscilloscope
10:1 Divider Probe

NOTE

WAVEFORM MEASUREMENTS TAKEN WITHOUT MEMORY CIRCUIT INSTALLED.

Procedure:
a. Turn on power and obtain primary test pattern on screen.

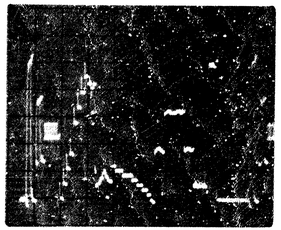
b. Connect oscilloscope to A1J5 Pin 2 and check for a display as shown in figure 5-12.



VERTICAL ATTENUATOR = 20mV/div.
SWEEP = 1 ms/div.

Figure 5-12. X-Amplifier Auxiliary Output

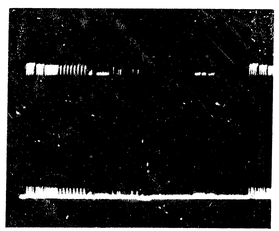
c. Monitor A1J4 Pin 2 and check oscilloscope for a display as shown in figure 5-13.



VERTICAL ATTENUATOR = 20mV/div.
SWEEP = 1 ms/div.

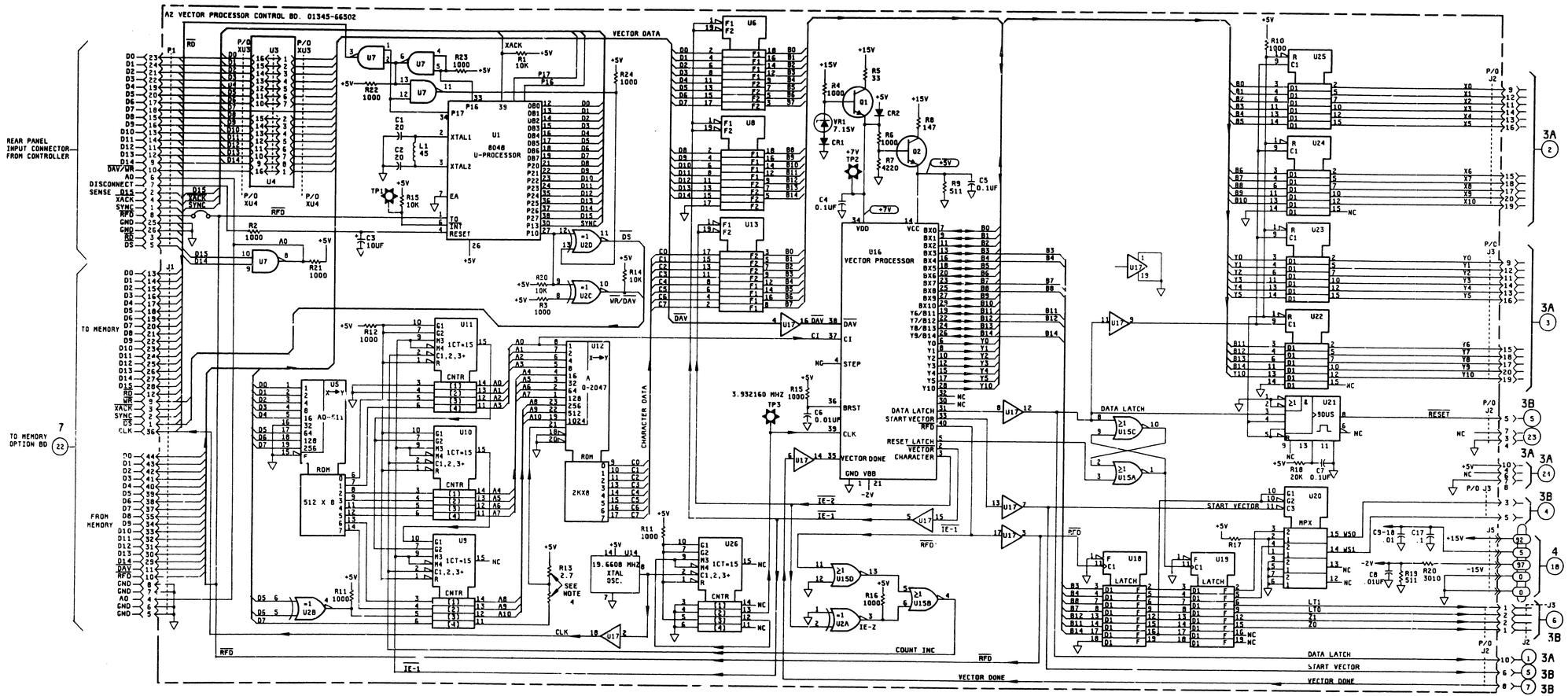
Figure 5-13. Y-Amplifier Auxiliary Output

d. Monitor A1J3 Pin 2 and check for a display on the oscilloscope as shown in figure 5-14.

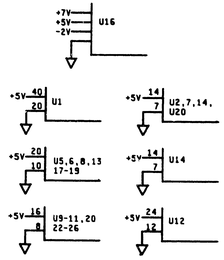


VERTICAL ATTENUATOR = 20mV/div.
SWEEP = 500 μs/div.

Figure 5-14. Z-Amplifier Auxiliary Output



IC DEVICE POWER CONNECTIONS



NOTES:

1. GATES ARE SYMBOLIZED ACCORDING TO CIRCUIT FUNCTION.
2. UNLESS OTHERWISE NOTED:
 RESISTANCE IN OHMS
 CAPACITANCE IN PICOFARADS
 INDUCTANCE IN MICROHENRIES
3. UNLESS OTHERWISE NOTED:
 LOGIC LEVELS ARE TTL:
 +2.0V TO +5.0V=LOGIC"1"=H
 0V TO +0.8V=LOGIC"0"=L
4. R13 SHOWN IN POSITION FOR 16K ROM. USE ALTERNATE POSITION FOR 32K ROM.
5. WHEN OPTION 704 IS INSTALLED, JUMPERS U3, AND U4 MUST BE REMOVED.

PARTS ON THIS SCHEMATIC

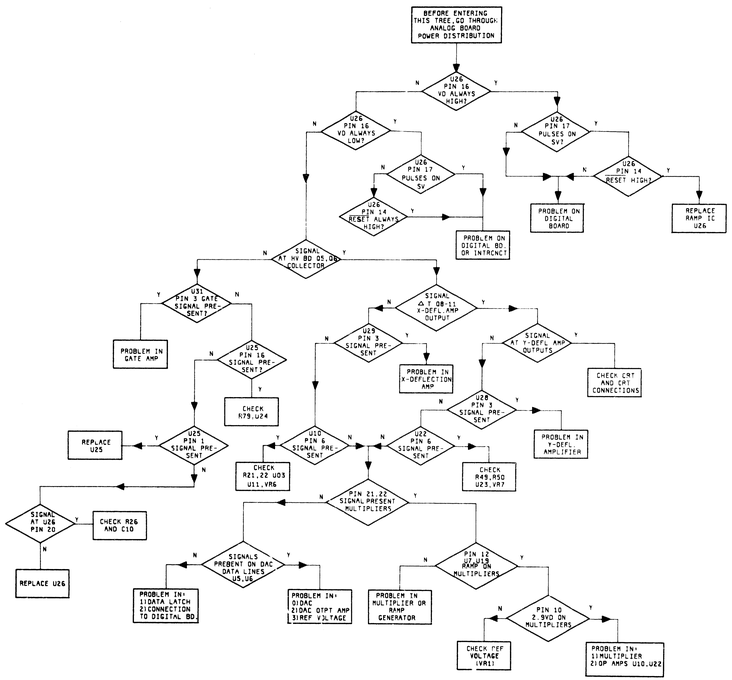
A2

C1-8,17
CR1,2
J1-3,5
L1
P1
Q1,2
R1-23
U1-26
VR1
W1
XU3,XU4

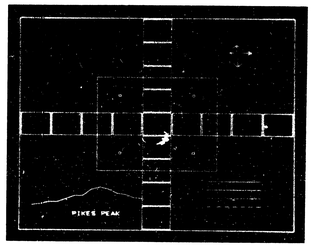
SERVICE SHEET 2

1345/106/CLG/04-16-81

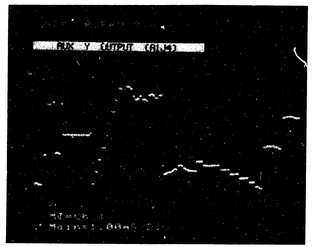
Figure 7-2.
Replacement for Service Sheet 2A and 2B.
Schematic Diagram Vector Processor Board (A2)
Part No. 01345-66502



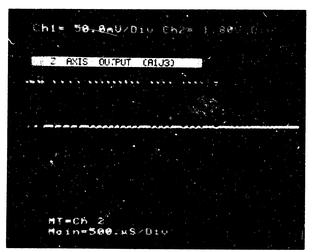
WAVEFORM MEASUREMENT CONDITION



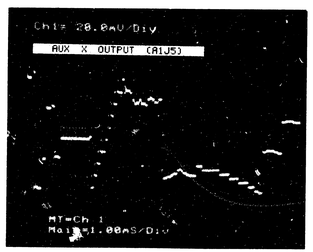
OBTAIN PRIMARY TEST PATTERN AS SHOWN ABOVE



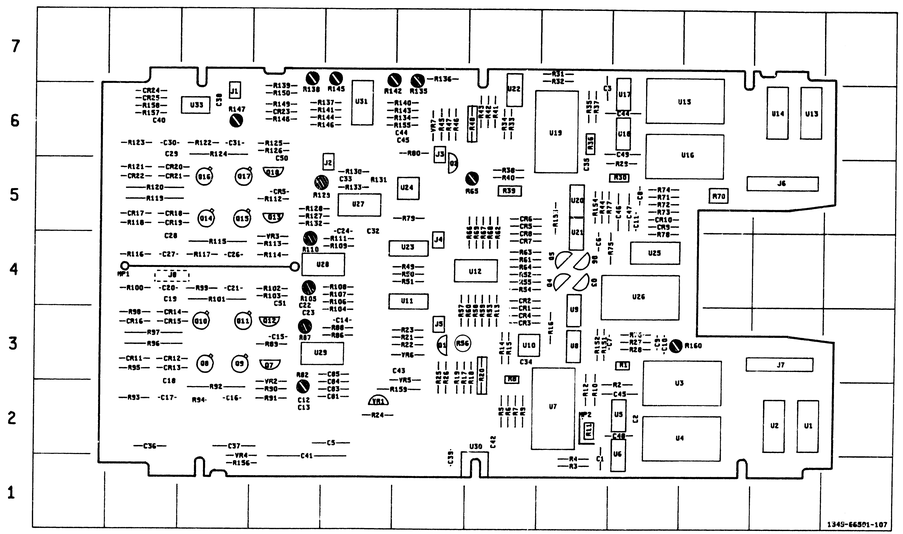
Y AUX OUTPUT AT A1J4



Z AUX OUTPUT AT A1J3

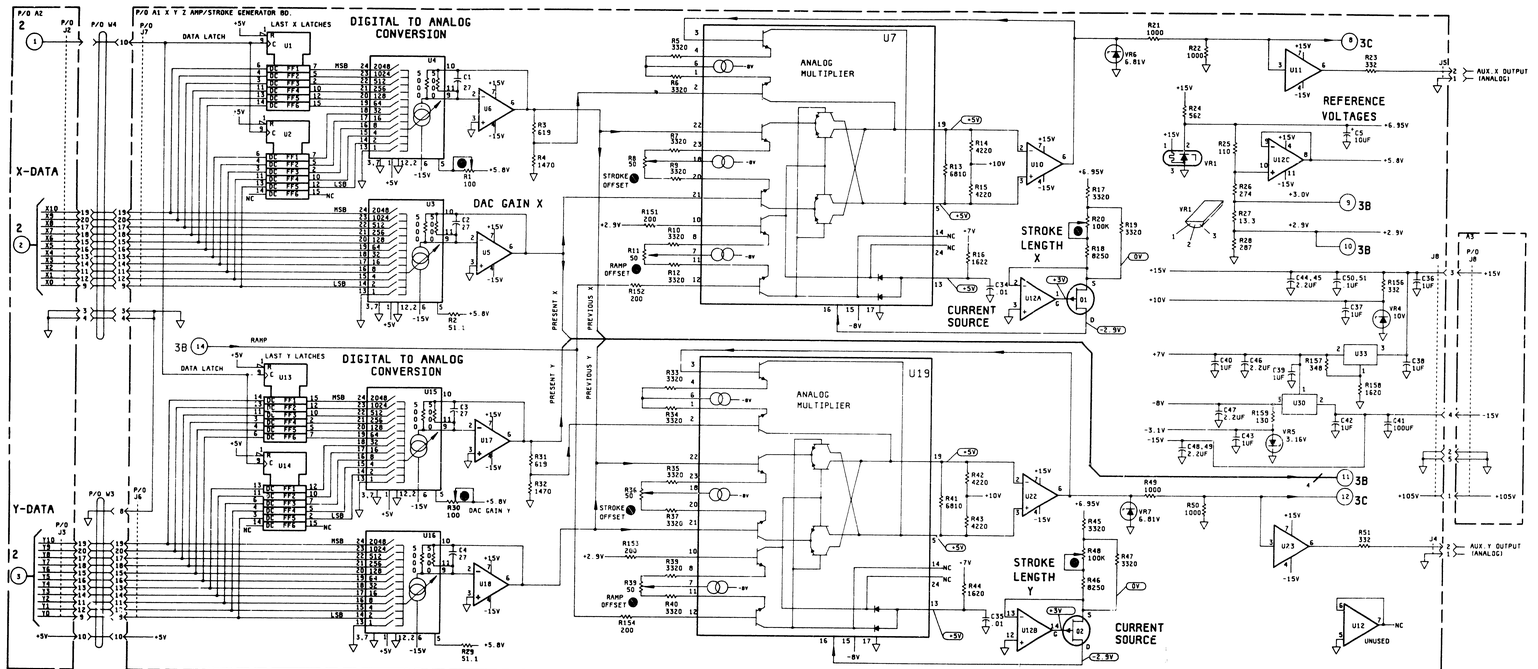


X AUX OUTPUT AT A1J5

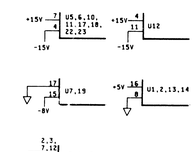


P/O Service Sheet 3A, X-Y-Z Amp/Stroke Generator (A1)

REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC
C1	J-1	CR11	B-3	R19	F-3	R80	F-6	R140	F-6
C2	K-2	CR12	B-3	R20	H-3	R81	E-2	R141	E-6
C3	J-6	CR13	B-3	R21	F-3	R82	D-3	R142	E-6
C4	J-6	CR14	B-3	R22	F-3	R83	E-2	R143	F-6
C5	E-2	CR15	B-3	R23	F-3	R84	E-2	R144	E-6
C6	J-4	CR16	B-3	R24	E-2	R85	E-3	R145	E-6
C7	K-3	CR17	B-5	R25	F-3	R86	E-5	R146	E-6
C8	K-4	CR18	B-5	R26	F-3	R87	D-3	R147	C-6
C9	K-3	CR19	B-5	R27	K-3	R88	E-3	R148	D-6
C10	K-3	CR20	B-5	R28	K-3	R89	D-3	R149	D-6
C11	K-4	CR21	B-5	R29	K-5	R90	D-2	R150	D-6
C12	D-2	CR22	B-5	R30	K-5	R91	D-2	R151	J-3
C13	D-2	CR23	D-6	R31	J-7	R92	C-2	R152	J-3
C14	E-3	CR24	B-4	R32	J-7	R93	B-2	R153	J-5
C15	D-3	CR25	B-6	R33	H-6	R94	C-2	R154	J-5
C16	C-2	J1	C-6	R34	H-6	R95	B-3	R155	F-6
C17	B-2	J2	E-5	R35	K-6	R96	B-3	R156	C-1
C18	B-2	J3	F-6	R36	J-6	R97	B-3	R157	B-6
C19	B-4	J4	F-4	R37	J-6	R98	B-3	R158	B-6
C20	B-4	J5	F-3	R38	H-5	R99	C-4	R159	F-2
C21	C-4	J6	M-5	R39	H-5	R100	B-4	R160	L-3
C22	D-3	J7	M-3	R40	H-5	R101	C-4	U1	M-2
C23	D-3	J8	B-4	R41	H-6	R102	D-3	U2	M-2
C24	E-4	MP1	B-4	R42	H-6	R103	D-3	U3	L-2
C25	D-5	MP2	J-2	R43	F-6	R104	E-3	U4	L-2
C26	C-4	Q1	F-3	R44	J-5	R105	D-4	U5	K-2
C27	B-4	Q2	F-5	R45	F-6	R106	E-4	U6	K-2
C28	B-4	Q3	J-4	R46	F-6	R107	E-4	U7	J-2
C29	B-6	Q4	J-4	R47	F-6	R108	E-4	U8	J-3
C30	B-6	Q5	J-4	R48	H-6	R109	E-4	U9	J-3
C31	C-6	Q6	J-4	R49	F-4	R110	D-4	U10	H-3
C32	E-4	Q7	D-3	R50	F-4	R111	E-4	U11	F-4
C33	E-5	Q8	C-3	R51	F-4	R112	D-5	U12	H-4
C34	H-3	Q9	C-3	R52	H-4	R113	D-4	U13	M-6
C35	J-5	Q10	C-3	R53	H-3	R114	D-4	U14	M-6
C36	B-2	Q11	C-3	R54	H-4	R115	C-4	U15	L-6
C37	C-2	Q12	D-3	R55	H-4	R116	B-4	U16	L-6
C38	C-6	Q13	D-5	R56	F-3	R117	C-4	U17	K-6
C39	F-1	Q14	D-5	R57	H-3	R118	B-5	U18	K-6
C40	B-6	Q15	C-5	R58	H-3	R119	B-5	U19	J-6
C41	D-1	Q16	C-5	R59	H-3	R120	B-5	U20	J-5
C42	H-2	Q17	C-5	R60	H-3	R121	B-5	U21	J-5
C43	F-3	Q18	B-5	R61	H-4	R122	C-5	U22	H-6
C44	F-6	R1	K-3	R62	H-4	R123	C-5	U23	F-4
C45	K-2	R2	K-2	R63	H-4	R124	C-6	U24	F-5
C46	K-5	R3	J-1	R64	H-4	R125	D-6	U25	K-4
C47	K-5	R4	J-1	R65	H-5	R126	D-6	U26	K-4
C48	K-2	R5	H-2	R66	H-4	R127	D-5	U27	E-5
C49	K-6	R6	H-2	R67	H-4	R128	D-5	U28	E-4
C50	D-5	R7	H-2	R68	H-4	R129	D-5	U29	D-3
C51	D-4	R8	H-3	R69	H-4	R130	E-5	U30	H-1
CR1	H-3	R9	H-2	R70	L-5	R131	E-5	U31	E-6
CR2	H-4	R10	J-2	R71	K-5	R132	D-5	U33	C-6
CR3	H-3	R11	J-2	R72	K-5	R133	E-5	VR1	E-2
CR4	H-3	R12	J-2	R73	K-5	R134	F-6	VR2	D-2
CR5	H-5	R13	H-3	R74	K-5	R135	F-6	VR3	D-4
CR6	H-5	R14	H-3	R75	J-5	R136	F-7	VR4	C-1
CR7	H-4	R15	H-3	R76	K-3	R137	E-6	VR5	F-2
CR8	H-4	R16	J-3	R77	J-5	R138	E-6	VR6	F-3
CR9	K-4	R17	F-3	R78	K-4	R139	D-6	VR7	F-6
CR10	K-4	R18	H-3	R79	F-5				



IC DEVICE POWER CONNECTIONS



NOTES:

1. GATES ARE SYMBOLIZED ACCORDING TO CIRCUIT FUNCTION.
2. UNLESS OTHERWISE NOTED: RESISTANCE IN OHMS CAPACITANCE IN PICOFARADS INDUCTANCE IN MICROHENRIES
3. UNLESS OTHERWISE NOTED: LOGIC LEVELS ARE TTL: +2.0V TO +5.0V=LOGIC"1"=H 0V TO +0.8V=LOGIC"0"=L

PARTS ON THIS SCHEMATIC

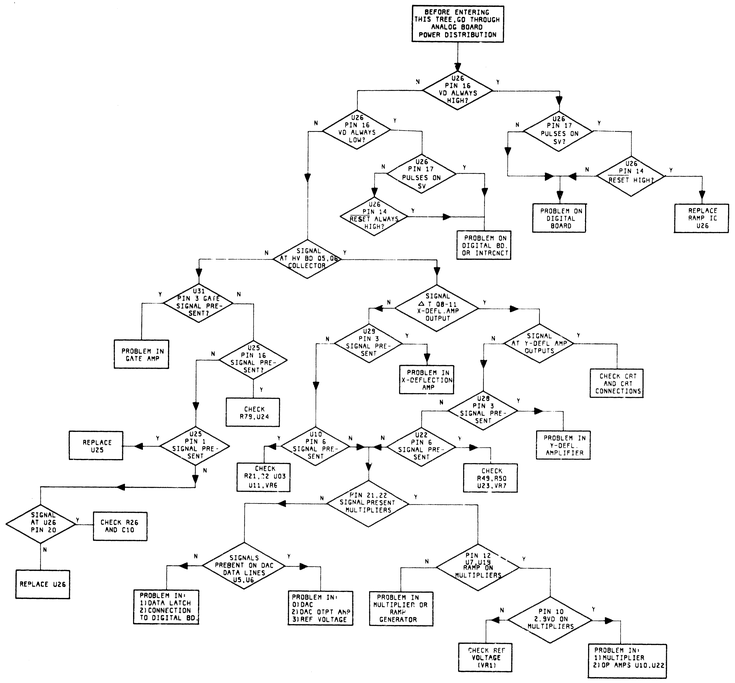
P/O A1

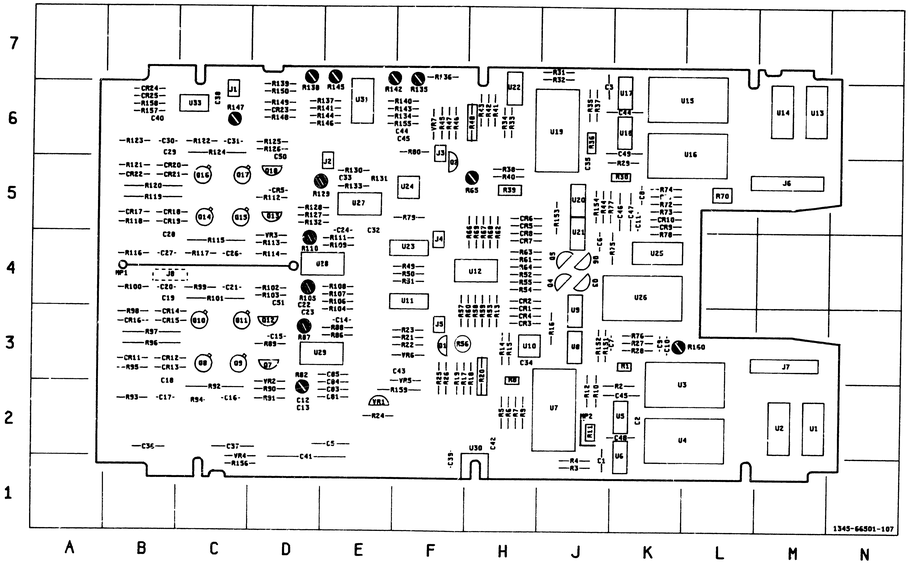
C1-5,34-51
J4-7
Q1,2
R1-51,151-154,156-159
U1-7,10-19,22,23,30,33
VR1,4,5

SERVICE SHEET 3A

1345/100/CLG/04-09-81

Figure 7-3.
Replacement for Service Sheet 3A. Schematic Diagram P/O X-Y-Z Amp/Stroke Generator (A1) Board. Part No. 01345-66501





REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC
C1	J-1	CR11	B-3	R19	F-3	R80	F-6	R140	F-6
C2	K-2	CR12	J-3	R20	H-3	R81	E-2	R141	E-6
C3	J-6	CR13	B-3	R21	F-3	R82	D-3	R142	E-6
C4	J-6	CR14	B-3	R22	F-3	R83	E-2	R143	E-6
C5	E-2	CR15	B-3	R23	F-3	R84	E-2	R144	E-6
C6	J-4	CR16	B-3	R24	E-2	R85	E-3	R145	E-6
C7	K-3	CR17	B-5	R25	F-3	R86	E-3	R146	E-6
C8	K-4	CR18	B-5	R26	F-3	R87	D-3	R147	C-6
C9	K-3	CR19	B-5	R27	K-3	R88	E-3	R148	D-6
C10	K-3	CR20	B-5	R28	K-3	R89	D-3	R149	D-6
C11	K-4	CR21	B-5	R29	K-5	R90	D-2	R150	D-6
C12	D-2	CR22	B-5	R30	J-7	R91	D-2	R151	J-3
C13	D-2	CR23	D-6	R31	J-7	R92	C-2	R152	J-3
C14	E-3	CR24	B-6	R32	J-7	R93	B-2	R153	J-5
C15	D-3	CR25	B-6	R33	H-6	R94	C-2	R154	J-5
C16	C-2		C-6	R34	H-6	R95	B-3	R155	F-6
C17	B-2	J2	E-5	R35	K-6	R96	B-3	R156	C-1
C18	B-2	J3	F-6	R36	J-6	R97	B-3	R157	B-6
C19	B-4	J4	F-4	R37	J-6	R98	B-3	R158	B-6
C20	B-4	J5	F-3	R38	H-5	R99	C-4	R159	F-2
C21	C-4	J6	M-5	R39	H-5	R100	B-4	R160	L-3
C22	D-3	J7	M-3	R40	H-5	R101	C-4	U1	M-2
C23	D-3	J8	B-4	R41	H-6	R102	D-3	U2	M-2
C24	E-4	MP1	B-4	R42	H-6	R103	D-3	U3	L-2
C25	D-5	MP2	J-2	R43	F-6	R104	E-3	U4	L-2
C26	C-4	Q1	F-3	R44	J-5	R105	D-4	U5	K-2
C27	B-4	Q2	F-5	R45	F-6	R106	E-4	U6	K-2
C28	B-4	Q3	J-4	R46	F-6	R107	E-4	U7	J-2
C29	B-6	Q4	J-4	R47	F-6	R108	E-4	U8	J-3
C30	B-6	Q5	J-4	R48	H-6	R109	E-4	U9	J-3
C31	C-5	Q6	J-4	R49	F-4	R110	D-4	U10	H-3
C32	E-4	Q7	D-3	R50	F-4	R111	E-4	U11	F-4
C33	E-3	Q8	C-3	R51	F-4	R112	D-5	U12	H-4
C34	H-3	Q9	C-3	R52	H-4	R113	D-4	U13	G-6
C35	J-5	Q10	C-3	R53	H-3	R114	D-4	U14	M-6
C36	B-2	Q11	F-3	R54	H-4	R115	C-4	U15	L-6
C37	C-2	Q12	D-3	R55	H-4	R116	B-4	U16	L-6
C38	C-6	Q13	D-5	R56	F-3	R117	C-4	U17	K-6
C39	F-1	Q14	C-5	R57	H-3	R118	B-5	U18	K-6
C40	B-6	Q15	C-5	R58	H-3	R119	B-5	U19	J-6
C41	C-1	Q16	C-5	R59	H-3	R120	D-5	U20	J-5
C42	H-2	Q17	C-5	R60	H-3	R121	B-5	U21	J-5
C43	F-3	Q18	D-5	R61	H-4	R122	C-5	U22	H-6
C44	F-6	R1	K-3	R62	H-4	R123	C-6	U23	F-4
C45	K-2	R2	K-2	R63	H-4	R124	C-6	U24	F-5
C46	K-5	R3	J-1	R64	H-4	R125	D-6	U25	K-4
C47	K-5	R4	J-1	R65	H-5	R126	D-5	U26	K-4
C48	K-6	R5	H-2	R66	H-4	R127	D-5	U27	E-5
C49	F-6	R6	H-2	R67	H-4	R128	D-5	U28	D-4
C50	D-5	R7	H-2	R68	H-4	R129	D-5	U29	D-3
C51	D-4	R8	H-3	R69	H-4	R130	E-5	U30	H-1
CR1	H-3	R9	H-2	R70	L-5	R131	E-5	U31	E-6
CR2	H-4	R10	J-2	R71	K-5	R132	D-5	U33	C-6
CR3	H-3	R11	J-2	R72	K-5	R133	E-5	VR1	E-2
CR4	H-3	R12	J-2	R73	K-5	R134	F-6	VR2	D-2
CR5	H-5	R13	H-3	R74	K-5	R135	F-6	VR3	D-4
CR6	H-5	R14	H-3	R75	J-5	R136	F-7	VR4	C-1
CR7	H-4	R15	H-3	R76	K-3	R137	E-6	VR5	F-2
CR8	H-4	R16	J-3	R77	J-5	R138	E-6	VR6	F-3
CR9	K-4	R17	F-3	R78	K-4	R139	D-6	VR7	F-6
CR10	K-4	R18	H-3	R79	F-5				

ADJUSTMENTS

5-15. STROKE INTENSITY ADJUSTMENT.

REFERENCE:
Service Sheet 3B.

DESCRIPTION:
This procedure describes the adjustments necessary to ensure equal intensity of all vectors.

EQUIPMENT REQUIRED:
Power Supply
Power Connector (Option 325)

PROCEDURE:
a. Turn on power and obtain primary test pattern on screen.

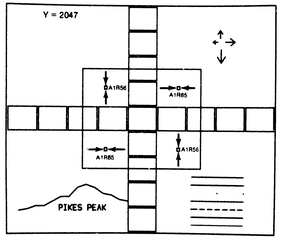


Figure 5-9. Stroke Intensity Adjustment

b. Adjust A1R56 so that the horizontal lines of the four small boxes in the test pattern are of equal intensity (see figure 5-9).

c. Adjust A1R65 so that the vertical lines of the four small boxes in the test pattern are of equal intensity.

Table 5-6. Stroke Intensity Adjustments

Reference Designator	Adjustment Name	Adjustment Paragraph	Service Sheet	Description
A1R56	X-CURRENT OFFSET	5-15, b	3B	Equal intensity of horizontal lines of four small boxes in the test pattern (figure 5-9)
A1R65	Y-CURRENT OFFSET	5-15, c	3B	Equal intensity of vertical lines of four small boxes in the test pattern (figure 5-9)

ADJUSTMENTS

5-16. FOCUS ADJUSTMENT AND RESOLUTION CHECK

REFERENCE:
Service Sheets 3C, 5.

DESCRIPTION:
These procedures provide the necessary adjustments for optimum focus of the display. To obtain an accurate resolution check, follow the steps in the same sequence as described below. The Focus Adjustment and Resolution Check consists of three parts:
1. Adjusting the Z-Axis Drive to +40V.
2. Adjusting Focus using the Secondary Test Pattern.
3. Verify Resolution using the Secondary Test Pattern.

EQUIPMENT REQUIRED:
Power Supply
Power Connector (Option 325)
Oscilloscope
10:1 Divider Probe

PROCEDURE:
1. Adjusting Z-Axis Drive to +40 V.

a. Disconnect I/O Port and apply power to the 1345A. The Primary Test Pattern should be displayed.

b. Monitor Test Point A4TP2 with an oscilloscope.

c. Set oscilloscope sweep speed to 2 milliseconds/div and vertical attenuator to 1 V/div. Use a 10:1 divider probe to obtain a 10 V/div deflection factor.

d. Turn Intensity Control (A1R129) fully counterclockwise.

e. Adjust Intensity Cut-Off Level (A1R31) so that the dot over the Y=2047 in the pattern is just extinguished. Shade the CRT face to make sure that the dot is not visible.

f. Disregarding overshoot, adjust Intensity Control (A1R129) for a +40 V p-p waveform. If +40 V cannot be obtained, set Intensity Control fully clockwise.

2. Focus Adjustment Procedure.

a. Short A2TP1 to Ground to display the Secondary Test Pattern.

b. Monitor Test Point A1TP10 with an oscilloscope and note the DC voltage (should be approximately 7.0 V). In making this measurement, DC couple the oscilloscope's vertical attenuator.

c. Monitor Test Point A1TP9 and adjust Y-Offset, A1R138, so that the baseline of the monitored signal is at the same DC level as noted in step b.

d. Connect oscilloscope to Test Point A1TP11 and adjust X-Offset A1R135, until the baseline of the monitored signal is at the same DC level as in step b.

e. Using a 10:1 divider probe to obtain a 10 V/div deflection factor, set oscilloscope attenuator to 1 V/div, dc coupled and sweep speed to 5 milliseconds/div. Monitor Test Point A4TP1 and adjust Fine Focus, A1R149, so that the baseline of displayed signal is at +50 V.

f. Adjust Focus, A4R42, for optimum focus of displayed pattern.

ADJUSTMENTS

g. Turn Intensity Control, A1R129, over its range of adjustment. The display should stay focused. If not, adjust Focus Gain A4R2 until pattern stays focused over the entire intensity range.

h. Adjust X-Gain, A1R142, for best focus at left and right edges of the pattern.

i. Adjust Y-Gain, A1R145, for best focus at top and bottom edges of the pattern. Steps h and i are interactive, therefore repeat those steps until optimum focus of all edges of the pattern is achieved.

j. Compare the pattern on screen with that shown in figure 5-10.

3. Checking CRT Resolution

a. Ensure that all the Z-Axis Drive and Focus adjustments have been performed.

b. A 1345A passes the Resolution Test if all of the individual lines in all 13 boxes of the pattern can be resolved. If the Resolution Test fails, repeat the Z-Axis Drive Adjustment and the Focus Adjustment Procedures. If the Resolution Test fails again, contact the Colorado Springs Division or your nearest Sales and Service Office for additional assistance.

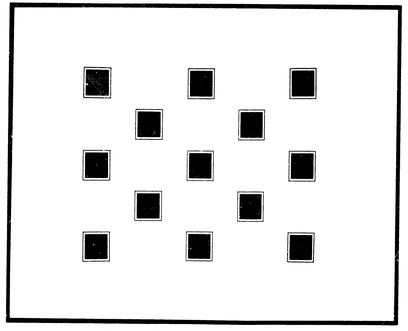
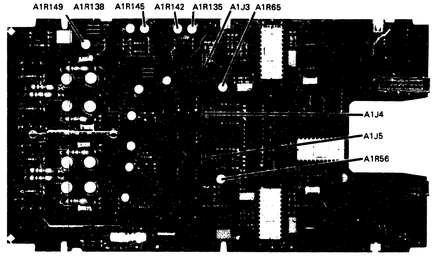


Figure 5-10. Test Pattern for Focus Adjustment

ADJUSTMENTS



NOTE: A4R2 AND A4R42 ARE LOCATED ON FIGURE 5-3

Figure 5-11. Stroke Instensity and Focus Adjustment Locations

Table 5-7. Z-Axis Drive and Focus Adjustments

Reference Designator	Adjustment Name	Adjustment Paragraph	Service Sheet	Description
A1R131	INTENSITY CUT-OFF LEVEL	5-16, e	3C	Adjust so that dot over Y=2047 in pattern is extinguished.
A1R129	INTENSITY CONTROL	5-16, f	3C	Adjust for a +40 V p-p waveform.
A1R138	Y-FOCUS OFFSET	5-16, d	3C	Monitor at A1TP9, adjust for a DC level as in step c (approx +7 V)
A1R135	X-FOCUS OFFSET	5-16, e	3C	Monitor at A1TP11, adjust for a DC level as in step c (approx. +7 V)
A1R149	FOCUS FINE ADJUST	5-16, f	3C	Monitor at A4TP1, adjust for base line level of +50 V
A4R42	FOCUS	5-16, g	5	Adjust for optimum focused test pattern.
A4R2	FOCUS GAIN	5-16, h	5	Adjust so that pattern stays focused over intensity range (A1R129)
A1R142	X-FOCUS GAIN	5-16, j	3C	Optimum focus of right and left edges of the secondary test pattern (figure 5-10)
A1R145	Y-FOCUS GAIN	5-16, k	3C	Optimum focus of top and bottom of the secondary test pattern (figure 5-10)

5-17. WRITING RATE ADJUSTMENT.

REFERENCE:
Service Sheet 3B.

DESCRIPTION:
This procedure describes the adjustments for writing speed.

EQUIPMENT REQUIRED:
Power Supply
Power Connector (Option 325)
Oscilloscope
10:1 Divider Probe

PROCEDURE:
a. Short A2TP1 to ground and turn on power to obtain the secondary test pattern on screen.

b. Monitor A1TP12 with the oscilloscope and adjust A1R70 so that the length of the second positive pulse in the frame is 90 μs (±2 μs) long.

c. Verify that the first pulse in the frame is approximately 117 μs long.

Table 5-8. Writing Rate Adjustment

Reference Designator	Adjustment Name	Adjustment Paragraph	Service Sheet	Description
A1R70	WRITING SPEED	5-17, b	3B	Monitor at A1TP12, adjust for 90 μs length of second positive pulse in the frame.

5-18. ASTIGMATISM AND PATTERN ADJUSTMENT.

REFERENCE:
Service Sheet 4.

DESCRIPTION:
These adjustment procedures are the "fine touch" adjustment for Astigmatism and Pattern.

EQUIPMENT REQUIRED:
Power Supply
Power Connector (Option 325)

PROCEDURE:
a. Turn on power and display the primary test pattern.

b. Adjust A4R40 for optimum pattern on the outer box of the primary test pattern.

c. Adjust A4R39 so that the astigmatism at the corners of the inner box of the test pattern is optimally adjusted.

Table 5-9. Astigmatism and Pattern Adjustment

Reference Designator	Adjustment Name	Adjustment Paragraph	Service Sheet	Description
A4R40	PATTERN ADJUST	5-18, b	5	Adjust for optimum pattern of the outer box in the primary test pattern
A4R39	ASTIGMATISM ADJUST	5-18, c	5	Adjust for optimum astigmatism at the corners of the inner box in the primary test pattern.

5-19. AUXILIARY X-Y-Z- OUTPUT CHECK.

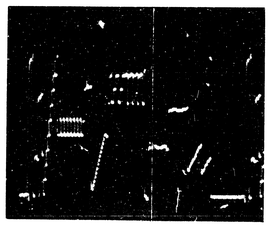
REFERENCE:
Service Sheets 3A, 3B.

DESCRIPTION:
This check verifies the auxiliary X-Y-Z Outputs.

EQUIPMENT REQUIRED:
Power Supply
Power Connector (Option 325)
Oscilloscope
10:1 Divider Probe

PROCEDURE:
a. Turn on power and obtain primary test pattern on screen.

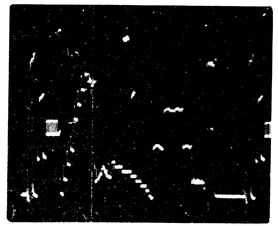
b. Connect oscilloscope to A1J5 Pin 2 and check for a display as shown in figure 5-12.



VERTICAL ATTENUATOR = 20 mV/div.
SWEEP = 1 ms/div.

Figure 5-12. X-Amplifier Auxiliary Output

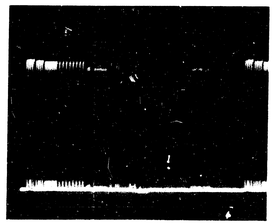
c. Monitor A1J4 Pin 2 and check oscilloscope for a display as shown in figure 5-13.



VERTICAL ATTENUATOR = 20 mV/div.
SWEEP = 1 ms/div.

Figure 5-13. Y-Amplifier Auxiliary Output

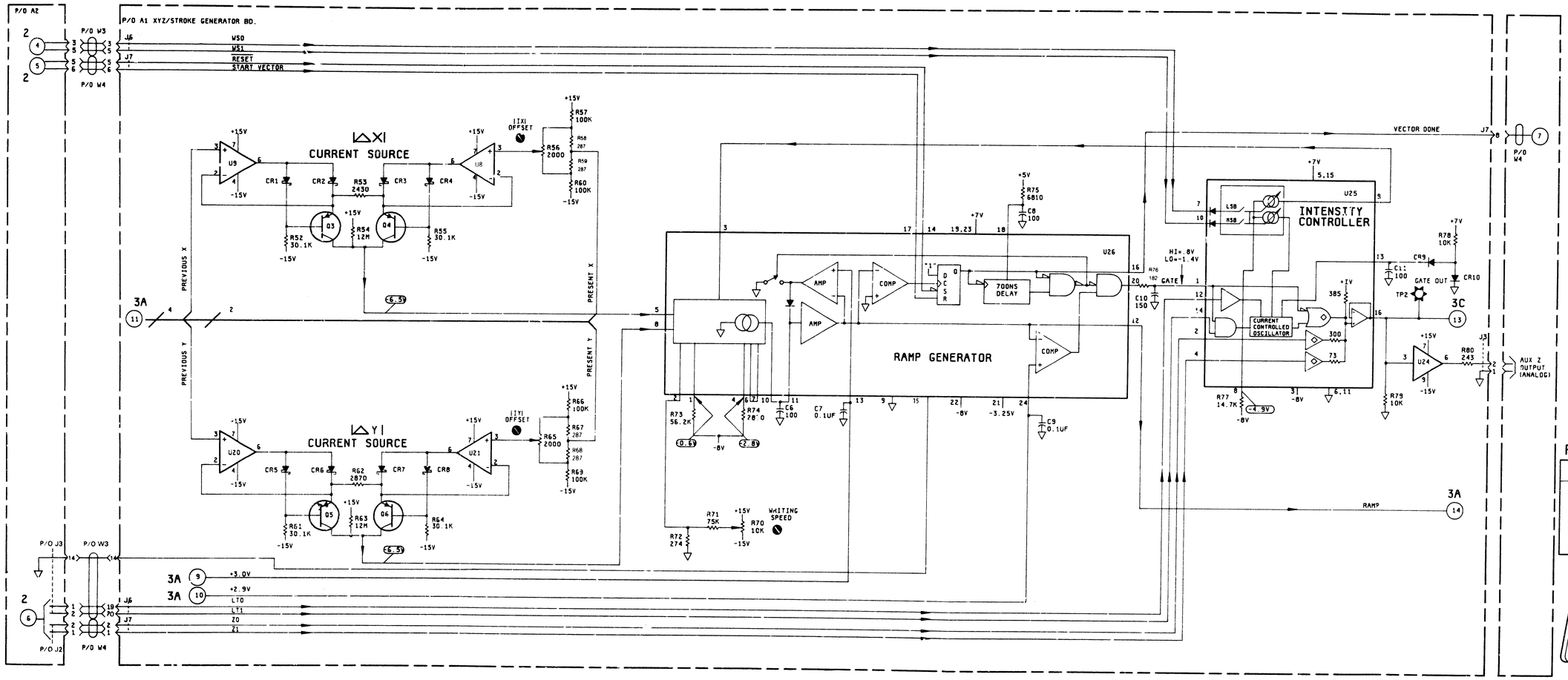
d. Monitor A1J3 Pin 2 and check for a display on the oscilloscope as shown in figure 5-14.



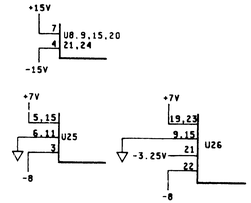
VERTICAL ATTENUATOR = 20 mV/div.
SWEEP = 500 μs/div.

Figure 5-14. Z-Amplifier Auxiliary Output

Replacement for Paragraphs 5-17, 5-18, and 5-19.



IC DEVICE POWER CONNECTIONS



NOTES:

1. GATES ARE SYMBOLIZED ACCORDING TO CIRCUIT FUNCTION.
2. UNLESS OTHERWISE NOTED:
 RESISTANCE IN OHMS
 CAPACITANCE IN PICOFARADS
 INDUCTANCE IN MICROHENRIES
3. UNLESS OTHERWISE NOTED:
 LOGIC LEVELS ARE TTL:
 +2.0V TO +5.0V=LOGIC "1"=H
 0V TO +0.8V=LOGIC "0"=L

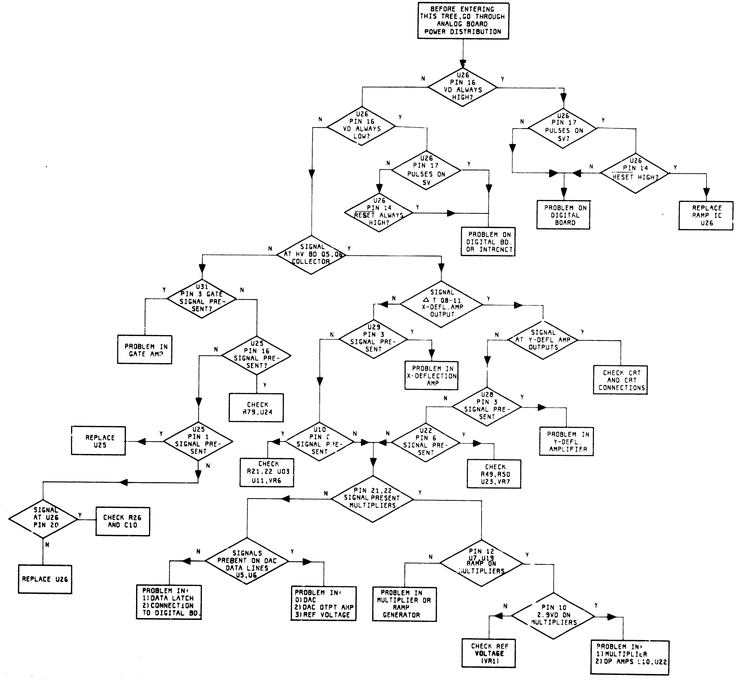
PARTS ON THIS SCHEMATIC

P/O A1	A[illegible]	CHASSIS
C6-11		P/O W3
CR1-10		P/O W4
J3,6,7		
Q3-6		
R52-80		
U8,9,20,21,24-26		

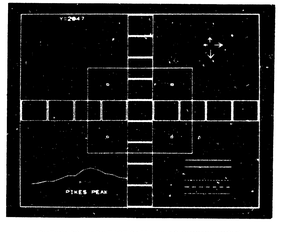
SERVICE SHEET 3B

1345/101/CLG/04-15-81

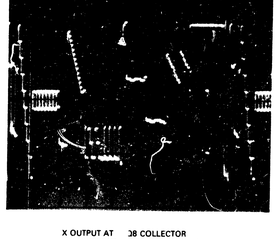
Figure 7-4.
Replacement for Service Sheet 3B. Schematic Diagram P/O X-Y-Z Amp/Stroke Generator (A1) Board. Part No. 01345-66510



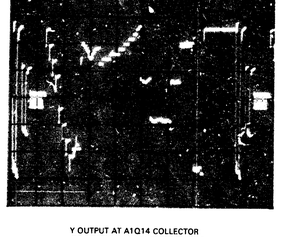
WAVEFORM MEASUREMENT CONDITION



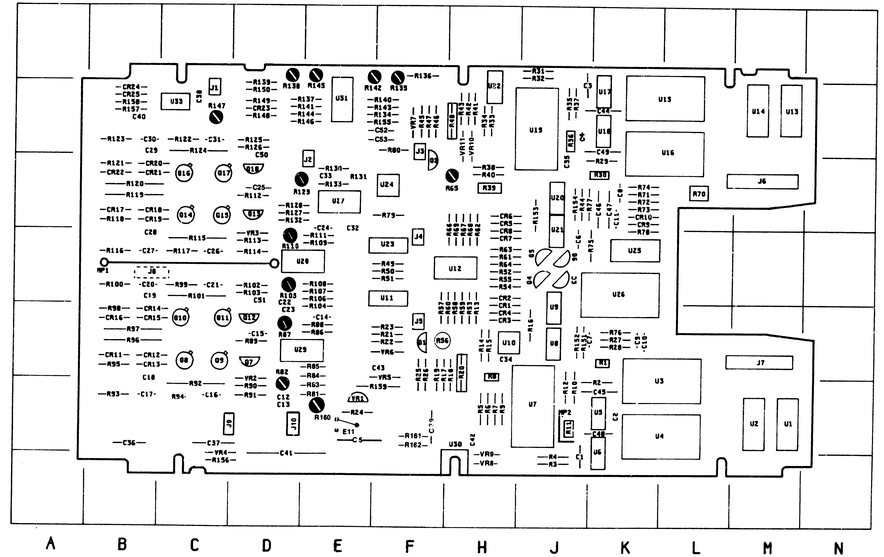
OBTAIN PRIMARY TEST PATTERN AS SHOWN ABOVE



X OUTPUT AT A3B COLLECTOR
(TO HORIZONTAL DEFLECTION PLATES)
10 V/DIV, 2ms/DIV

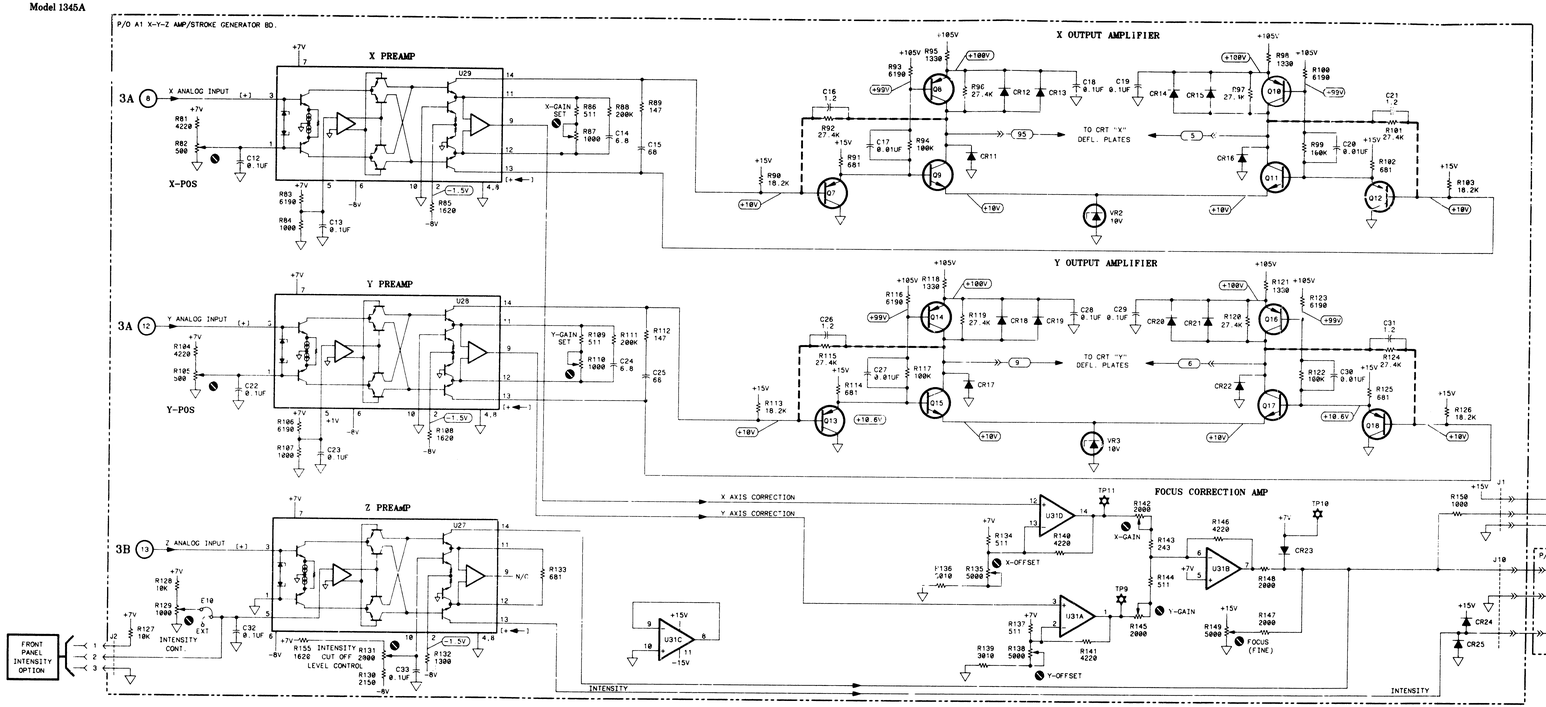


Y OUTPUT AT A1Q14 COLLECTOR
(TO VERTICAL DEFLECTION PLATES)
10 V/DIV, 2 ms/DIV

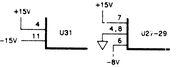


P/O Service Sheet 3C, X-Y-Z Amp/Stroke Generator (A1)

REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC
C1	J-1	CR3	F-8	Q17	C-5	R51	F-4	R103	D-4	R156	C-1
C2	K-2	CR1	H-3	Q18	D-5	R52	H-4	R104	E-3	R157	B-6
C3	J-6	CR2	H-4	R1	K-3	R53	H-3	R105	D-5	R158	B-6
C4	J-8	CR3	H-3	R2	K-2	R54	H-4	R106	E-4	R159	F-2
C5	E-2	CR4	H-3	R3	J-1	R55	H-4	R107	E-4	R160	E-2
C6	J-4	CR5	H-5	R4	J-1	R56	F-3	R108	E-4	R161	F-2
C7	K-3	CR6	H-5	R5	H-2	R57	H-3	R109	E-4	R162	F-2
C8	K-4	CR7	H-4	R6	H-2	R58	H-3	R110	D-4	U1	M-2
C9	F-3	CR8	H-4	R7	H-2	R59	H-3	R111	E-4	U2	M-2
C10	K-3	CR9	K-4	R8	H-3	R60	H-3	R112	D-5	U3	L-2
C11	K-4	CR10	K-4	R9	H-2	R61	H-4	R113	D-4	U4	L-2
C12	D-2	CR11	B-3	R10	J-2	R62	H-4	R114	D-4	U5	K-2
C13	D-2	CR12	B-3	R11	J-2	R63	H-4	R115	C-4	U6	K-2
C14	E-3	CR13	B-3	R12	J-2	R64	H-4	R116	B-4	U7	J-2
C15	D-3	CR14	B-3	R13	H-3	R65	H-5	R117	C-4	U8	J-3
C16	C-2	CR15	B-3	R14	H-3	R66	H-4	R118	B-5	U9	J-3
C17	B-2	CR16	B-3	R15	H-3	R67	H-4	R119	B-5	U10	H-3
C18	B-2	CR17	B-5	R16	J-3	R68	H-4	R120	B-5	U11	F-4
C19	B-4	CR18	B-5	R17	F-3	R69	H-4	R121	B-5	U12	H-4
C20	B-4	CR19	B-5	R18	H-3	R70	L-5	R122	C-6	U13	M-6
C21	C-4	CR20	B-5	R19	F-3	R71	K-5	R123	B-6	U14	M-8
C22	D-3	CR21	B-5	R20	H-3	R72	K-5	R124	C-6	U15	L-6
C23	D-3	CR22	B-5	R21	F-3	J73	K-5	R125	D-6	U16	L-6
C24	E-4	CR23	D-6	R22	F-3	R74	K-5	R126	D-6	U17	K-6
C25	D-5	CR24	B-6	R23	F-3	R75	J-4	R127	D-5	U18	K-6
C26	C-4	CR25	B-6	R24	E-2	R76	K-3	J128	D-5	U19	J-6
C27	B-4	J1	C-6	R25	F-3	R77	J-5	R129	D-5	U20	J-5
C28	B-4	J2	E-5	R26	F-3	R78	K-4	R130	E-5	U21	J-5
C29	B-6	J3	F-6	R27	K-3	R79	F-5	R131	E-5	U22	H-6
C30	B-6	J4	F-4	R28	K-3	R80	F-6	R132	D-5	U23	F-4
C31	C-6	J5	F-3	R29	K-5	R81	E-2	R133	E-5	U24	F-5
C32	E-4	J6	M-5	R30	K-5	R82	D-3	R134	F-6	U25	K-4
C33	E-5	J7	M-3	R31	J-7	R83	E-2	R135	F-6	U26	K-4
C34	H-3	J8	B-4	R32	J-7	R84	E-2	R136	F-6	U27	E-5
C35	J-5	J9	B-4	R33	H-6	R85	E-3	R137	E-6	U28	D-4
C36	B-2	J10	D-4	R34	H-6	R86	E-3	R138	D-6	U29	D-3
C37	C-2	Q1	F-3	R35	K-6	R87	D-3	R139	D-6	U30	H-1
C38	C-6	Q2	F-5	R36	J-6	R88	E-3	R140	F-6	U31	L-6
C39	F-1	Q3	J-4	R37	J-5	R89	D-3	R141	E-6	U32	N-A
C40	B-6	Q4	J-4	R38	H-5	R90	D-2	R142	E-6	U33	C-6
C41	D-1	Q5	J-4	R39	H-5	R91	D-2	R143	F-6	VR1	E-2
C42	H-2	Q6	J-4	R40	H-5	R92	C-2	R144	E-6	VR2	D-2
C43	F-3	Q7	D-3	R41	H-6	R93	B-2	R145	E-6	VR3	D-4
C44	K-6	Q8	C-3	R42	H-6	R94	C-2	R147	C-6	VR4	C-1
C45	K-3	Q9	C-3	R4..	F-6	R95	B-3	R148	C-6	VR5	F-2
C46	K-5	Q10	C-3	R44	J-5	R96	B-3	R149	D-6	VR6	F-3
C47	K-5	Q11	C-3	R45	F-6	R97	B-3	R153	D-6	VR7	F-6
C48	K-2	Q12	D-3	R46	F-6	R98	B-3	R151	J-3	VR8	H-1
C49	K-6	Q13	D-5	R47	F-6	R99	C-4	R152	J-3	VR9	H-1
C50	D-5	Q14	C-5	R48	H-6	R100	B-4	R153	J-5	VR10	H-5
C51	D-4	Q15	C-5	R49	F-4	R101	C-4	R154	J-5	VR11	H-6
C52	F-8	Q16	C-5	R50	F-4	R102	D-4	R155	F-6		



IC DEVICE POWER CONNECTIONS



NOTES:

1. GATES ARE SYMBOLIZED ACCORDING TO CIRCUIT FUNCTION.
2. UNLESS OTHERWISE NOTED:
 RESISTANCE IN OHMS
 CAPACITANCE IN PICOFARADS
 INDUCTANCE IN MICROHENRIES
3. UNLESS OTHERWISE NOTED:
 LOGIC LEVELS ARE TTL:
 +2.8V TO +5.0V=LOGIC"1"=H
 0V TO +0.8V=LOGIC"0"=L

PARTS ON THIS SCHEMATIC
P/O A1
C12-33
CR11-25
J1,2,10
Q7-18
R81-150,155
U27-29,31
VR2,3

S1345053/2-22-85

3C

Figure 7-5.
Replacement for Service Sheet 3C. Schematic Diagram P/O X-Y-Z Amp/Stroke Generator (A1) Board. Part No. 01345-66510

SECTION VI

REPLACEABLE PARTS

6-1. INTRODUCTION.

6-2. This section contains information for ordering parts. Table 6-1 lists abbreviations used in the parts list, table 6-2 lists all replaceable parts in reference designator order.

6-3. ABBREVIATIONS.

6-4. Table 6-1 lists abbreviations used in the parts list, the schematics, and throughout the manual. In some cases, two forms of the abbreviations are used, one all in capital letters, and one partial or no capitals. This occurs because the abbreviations in the parts list are always all capitals. However, in other parts of the manual other abbreviation forms are used with both lower and uppercase letters.

6-5. REPLACEABLE PARTS LIST.

6-6. Table 6-2 is the list of replaceable parts and is organized as follows:

a. Electrical assemblies in alphanumerical order by reference designation.

b. Chassis-mounted parts in alphanumerical order by reference designation.

c. Electrical assemblies and their components in alphanumerical order by reference designation.

The information given for each part consists of the following:

a. Complete reference designation.

b. Hewlett-Packard part number.

c. Total quantity (Qty) in instrument.

d. Description of part.

e. Check digit.

The total quantity for each part is only given once — at the first appearance of the part number in the list.

6-7. ORDERING INFORMATION.

6-8. To order a part listed in the replaceable parts table, quote the Hewlett-Packard part number, check digit, indicate the quantity required, and address the order to the nearest Hewlett-Packard office.

6-9. To order a part that is not listed in the replaceable parts table, include the instrument model number, instrument serial number, the description and function of the part, and number of parts required. Address the order to the nearest Hewlett-Packard office.

6-10. DIRECT MAIL ORDER SYSTEM.

6-11. Within the USA, Hewlett-Packard can supply parts through a direct mail order system. Advantages of using the system are as follows:

a. Direct ordering and shipment from HP Parts Center in Mountain View, California.

b. No maximum or minimum on any mail order (there is a minimum order amount for parts ordered through local HP offices when orders require billing and invoicing).

c. Prepaid transportation (there is a small handling charge for each order).

d. No invoices — to provide these advantages, check or money order must accompany each order.

6-12. Mail order forms and specific ordering information are available through your local HP offices.

Table 6-1. Reference Designators and Abbreviations.

REFERENCE DESIGNATORS

A	=assembly
B	=fan;motor
BT	=battery
C	=capacitor
CR	=diode;diode thyristor; varactor
DL	=delay line
DS	=annunciator;lamp;LED
E	=misc. electrical part
F	=fuse
FL	=filter
H	=hardware
J	=electrical connector (stationary portion);jack
L	=coil;inductor
MP	=misc. mechanical part
P	=electrical connector (moveable portion);plug
Q	=transistor;SCR; triode thyristor
R	=resistor
RT	=thermistor
S	=switch;jumper
T	=transformer
TB	=terminal board
TP	=test point
U	=integrated circuit; microcircuit
V	=electron tube; glow lamp
VR	=voltage regulator, breakdown diode
W	=cable
X	=socket
Y	=crystal unit(piezo-electric or quartz)

ABBREVIATIONS

A	=amperes
A/D	=analog-to-digital
AC	=alternating current
ADJ	=adjust(ment)
AL	=aluminum
AMPL	=amplifier
ANLG	=analog
ANSI	=American National Standards Institute
ASSY	=assembly
ASTIG	=astigmatism
ASYNCHRO	=asynchronous
ATTEN	=attenuator
AWG	=American wire gauge
BAL	=balance
BCD	=binary-code decimal
BD	=board
BFR	=buffer
BIN	=binary
BRDG	=bridge
BSHG	=bushing
BW	=bandwidth
C	=ceramic;cermet (resistor)
CAL	=calibrate;calibration
CC	=carbon composition
CCW	=counterclockwise
CER	=ceramic
CFM	=cubic feet/minute
CH	=choke
CHAM	=chamfered
CHAN	=channel
CHAR	=character
CM	=centimeter
CMOS	=complementary metal-oxide-semiconductor
CMR	=common mode rejection
CNDCT	=conductor
CNTR	=counter
CON	=connector
CONT	=contact
CRT	=cathode-ray tube
CW	=clockwise
D	=diameter
D/A	=digital-to-analog
DAC	=digital-to-analog converter
DARL	=darlington
DAT	=data
DBL	=double
DBM	=decibel referenced to 1mW
DC	=direct current
DCDR	=decoder
DEG	=degree
DEMUX	=demultiplexer
DET	=detector
DIA	=diameter
DIP	=dual in-line package
DIV	=division
DMA	=direct memory access
DPDT	=double-pole, double-throw
DRC	=DAC refresh controller
DRVR	=driver
DWL	=dowel
ECL	=emitter coupled logic
ELAS	=elastomeric
EXT	=external
F	=farads;metal film (resistor)
FC	=carbon film/ composition
FD	=feed
FEM	=female
FF	=flip-flop
FL	=flat
FM	=foam,from
FR	=front
FT	=gain bandwidth product
FW	=full wave
FXD	=fixed
GEN	=generator
GND	=ground(ed)
GP	=general purpose
GRAT	=graticule
GRV	=groove
H	=henries;high
HD	=hardware
HDND	=hardened
HG	=mercury
HGT	=height
HLCL	=helical
HORIZ	=horizontal
HP	=Hewlett-Packard
HP-IB	=Hewlett-Packard Interface Bus
HR	=hour(s)
HV	=high voltage
HZ	=Hertz
I/O	=input/output
IC	=integrated circuit
ID	=inside diameter
IN	=inch
INCL	=include(s)
INCAND	=incandescent
INP	=input
INTEN	=intensity
INTL	=internal
INV	=inverter
JFET	=junction field-effect transistor
JKT	=jacket
K	=kilo(10^3)
L	=low
LB	=pound
LCH	=latch
LCL	=local
LED	=light-emitting diode
LG	=long
LI	=lithium
LK	=lock
LKWR	=lockwasher
LS	=low power Schottky
LV	=low voltage
M	=mega(10^6);megohms; meter(distance)
MACH	=machine
MAX	=maximum
MFR	=manufacturer
MICPROC	=microprocessor
MINTR	=miniature
MISC	=miscellaneous
MLD	=molded
MM	=millimeter
MO	=metal oxide
MTG	=mounting
MTLC	=metallic
MUX	=multiplexer
MW	=milliwatt
N	=nano(10^{-9})
NC	=no connection
NMOS	=n-channel metal-oxide-semiconductor
NPN	=negative-positive-negative
NPRN	=neoprene
NRFR	=not recommended for field replacement
NSR	=not separately replaceable
NUM	=numeric
OBD	=order by description
OCTL	=octal
OD	=outside diameter
OP AMP	=operational amplifier
OSC	=oscillator
P	=plastic
P/O	=part of
PC	=printed circuit
PCB	=printed circuit board
PD	=power dissipation
PF	=picofards
PI	=plug in
PL	=plate(d)
PLA	=programmable logic array
PLST	=plastic
PNP	=positive-negative-positive
POLYE	=polyester
POS	=positive;position
POT	=potentiometer
POZI	=pozidrive
PP	=peak-to peak
PPM	=parts per million
PRCN	=precision
PREAMP	=preamplifier
PRGMBL	=programmable
PRL	=parallel
PROG	=programmable
PSTN	=position
PT	=point
PW	=potted wirewound
PWR	=power
R-S	=reset-set
RAM	=random-access memory
RECT	=rectifier
RET	=retainer
RF	=radio frequency
RGLTR	=regulator
RGTR	=register
RK	=rack
RMS	=root-mean-square
RND	=round
ROM	=read-only memory
RPG	=rotary pulse generator
RX	=receiver
S	=Schottky-clamped; seconds(time)
SCR	=screw;silicon controlled rectifier
SEC	=second(time);secondary
SEG	=segment
SEL	=selector
SGL	=single
SHF	=shift
SI	=silicon
SIP	=single in-line package
SKT	=skirt
SL	=slide
SLDR	=solder
SLT	=slot(ted)
SOLD	=solenoid
SPCL	=special
SQ	=square
SREG	=shift register
SRQ	=service request
STAT	=static
STD	=standard
SYNCHRO	=synchronous
TA	=tantalum
TBAX	=tubeaxial
TC	=temperature coefficient
TD	=time delay
THD	=thread(ed)
THK	=thick
THRU	=through
TP	=test point
TPG	=tapping
TPL	=triple
TRANS	=transformer
TRIG	=trigger(ed)
TRMR	=trimmer
TRN	=turn(s)
TTL	=transistor transistor
TX	=transmitter
U	=micro(10^{-6})
UL	=Underwriters Laboratory
UNREG	=unregulated
VA	=voltampere
VAC	=volt,ac
VAR	=variable
VCO	=voltage-controlled oscillator
VDC	=volt,dc
VERT	=vertical
VF	=voltage,filtered
VS	=versus
W	=watts
W/	=with
W/O	=without
WW	=wirewound
XSTR	=transistor
ZNR	=zener
°C	=degree Celsius (Centigrade)
°F	=degree Fahrenheit
°K	=degree Kelvin

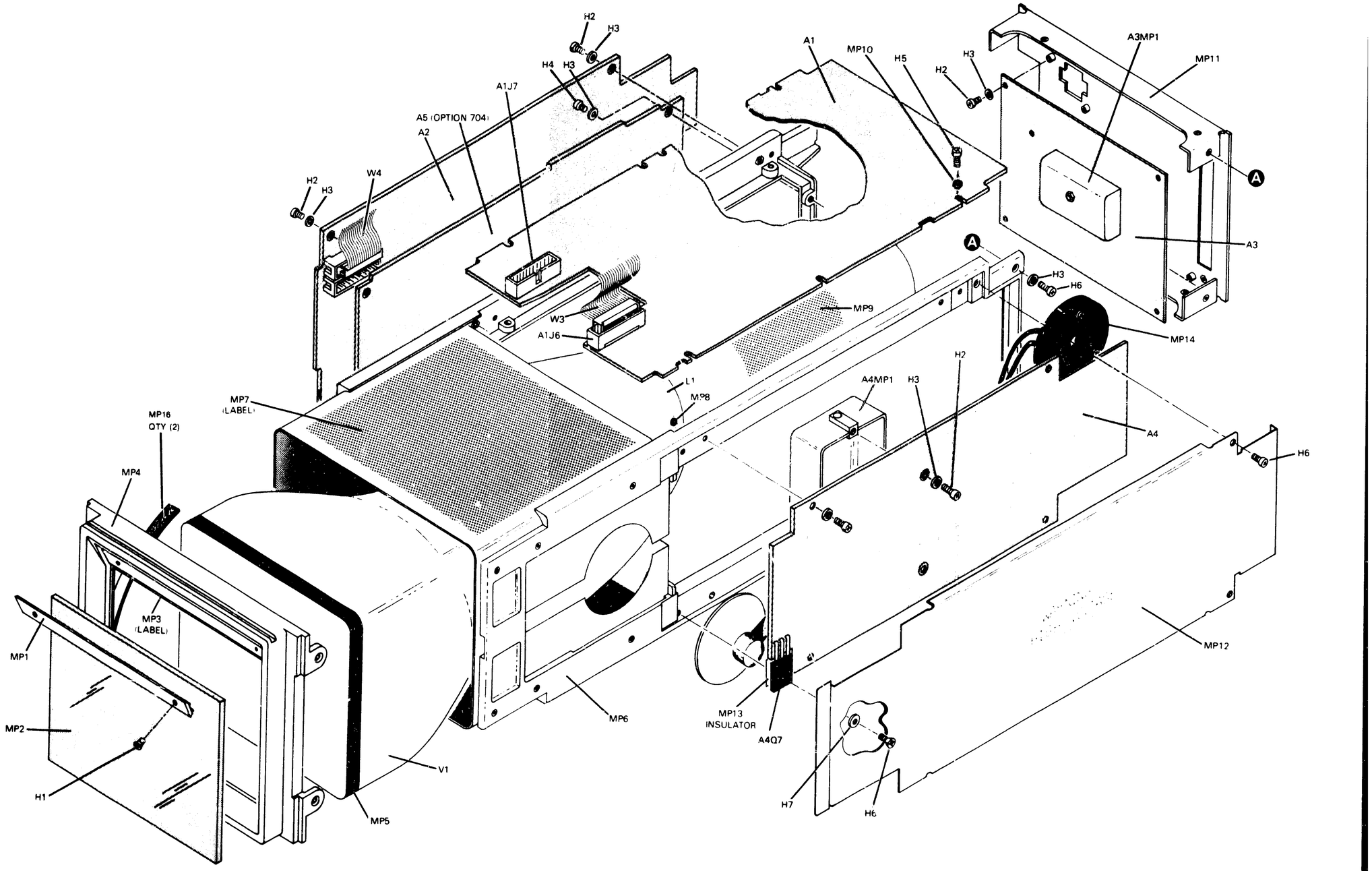


Figure 6-1.
Chassis Parts and Board Assembly Identification

Table 6-2. Replaceable Parts (Cont'd)

Reference Designator	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A1	01345-66529	0	1	BOARD-XY/STR GEN	28480	01345-66529
A2	01345-66527	8	1	BOARD-VECT PROC	28480	01345-66527
A3	01345-66509	6	1	BOARD ASSEMBLY-LV	28480	01345-66509
A4	01345-66523	4	1	BOARD ASSEMBLY-HV	28480	01345-66523
A5(OPTION 704)	01345-66528	9	1	MEMORY BOARD	28480	01345-66528
H1	0520-0164	1	2	SCREW-MACH 2-56 .25-IN-LG 82 DEG	28480	0520-0164
H2	0515-0055	8	13	SCREW-MACH M3 X 0.5 6MM-LG-PAN-HD	28480	0515-0055
H3	2190-0005	0	13	WASHER-LK EXT T NO. 4 .116-IN-ID	28480	2190-0005
H4	0515-0077	4	1	SCREW-MACH M3 X 0.5 10MM-LG	28480	0515-0077
H5	0515-0105	9	2	SCREW-MACH M3 X 0.5 12-MM-LG PAN-HD	28480	0515-0105
H6	0515-0219	3	10	SCREW-MACH M3 X 0.5 6MM-LG 90-DEG-FL-HD	28480	0515-0219
H7	3050-0098	6	3	WASHER-FL MTLC NO. 2 .094-IN-ID	28480	3050-0098
H8	3050-1039	7	1	WASHER-FL	28480	3050-1039
H9	0624-0289	1	3	SCREW-TPG 2-28 .312-IN-LG PAN HD-POZI	28480	0624-0289
H10	2190-0045	8	3	WASHER-LK HLCL NO. 2 .088-IN-ID	28480	2190-0045
H11	2190-0584	0	6	WASHER-LK HLCL 3.1MM-ID	28480	2190-0584
H12	3050-0105	6	6	WASHER-FL	28480	3050-0105
L1	01340-66001	8	1	TR ALIGN COIL	28480	01340-66001
MP1	01340-04101	9	1	FILTER-RETAINER	28480	01340-04101
MP2	1000-0645	2	1	CONTRAST-FILTER	28480	1000-0645
MP3	7120-3812	1	1	LABEL-WARNING .1-IN-WD 2.6-IN-LG MYLAR	28480	7120-3812
MP4	5040-8381	7	1	BEZEL-FRONT PANEL	28480	5040-8381
MP5	4320-0311	0	1	RUBBER SHOCK	28480	4320-0311
MP6	01345-60605	1	1	SHIELD-SUP SUB ASSEMBLY	28480	01345-60605
MP7	7121-4219	6	1	LABEL-CAL	28480	7121-4219
MP8	0400-0009	9	1	GROMMET-RND .125-IN-ID .25-IN-GRV-OD	28480	0400-0009
MP9	7121-2139	5	1	LABEL-INFO	28480	7121-2139
MP10	0340-0977	2	2	INSULATOR-FLG-BSHG NYLON	28480	0340-0977
MP11	01345-00202	8	1	PANEL-REAR	28480	01345-00202
MP12	01345-00601	1	1	SHIELD-OUTER HV	28480	01345-00601
MP13	0340-0564	3	1	INSULATOR-XSTR THRM-CNDCT	28480	0340-0564
MP14	5040-7648	7	1	PLATE-COVER, CRT	28480	5040-7648
MP15	0340-1031	1	2	SHOCK MOUNT-FRT	28480	0340-1031
MP16				NOT ASSIGNED		
MP113	01345-04701	0	1	SUPPORT-PC BOARD (OPTION 704)	28480	01345-04701
V1	5083-6451	8	1	CRT-P31 ALIGN	28480	5083-6451
W1	01345-61604	2	2	CABLE ASSEMBLY POWER	28480	01345-61604
W2	01345-61604	2		CABLE ASSEMBLY POWER	28480	01345-61604
W3	01345-61601	9	1	CABLE ASSEMBLY	28480	01345-61601
W4	01345-61602	0	1	CABLE ASSEMBLY	28480	01345-61602
W5	01345-61605	3	1	CABLE ASSEMBLY POWER	28480	01345-61605
W6	01345-61607	5	1	CABLE ASSEMBLY-DATA	28480	01345-61607
W7	01345-61608	6	1	CABLE ASSEMBLY POWER	28480	01345-61608
W8	01345-61609	7	1	CABLE ASSEMBLY	28480	01345-61609
W9	01345-61610	0	1	CABLE ASSEMBLY	28480	01345-61610
W10	01345-61611	1	1	CABLE ASSEMBLY	28480	01345-61611

See introduction to this section for ordering information

Table 6-2. Replaceable Parts (Cont'd)

Reference Designator	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A1	01345-66529	0	1	BOARD-XY/STR GEN	28480	01345-66529
A1C1	0160-3569	2	4	CAPACITOR FXD 27PF +-5% 100VDC CER 0+-30	28480	0160-3569
A1C2	0160-3569	2		CAPACITOR FXD 27PF +-5% 100VDC CER 0+-30	28480	0160-3569
A1C3	0160-3569	2		CAPACITOR FXD 27PF +-5% 100VDC CER 0+-30	28480	0160-3569
A1C4	0160-3569	2		CAPACITOR FXD 27PF +-5% 100VDC CER 0+-30	28480	0160-3569
A1C5	0180-0374	3	1	CAPACITOR-FXD 10UF +-10% 20VDC TA	56289	150D106X9020B2
A1C6	0160-2204	0	3	CAPACITOR-FXD 100PF +-5% 300VDC MICA	28480	0160-2204
A1C7	0160-3443	1	2	CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	0160-3443
A1C8	0160-2204	0		CAPACITOR-FXD 100PF +-5% 300VDC MICA	28480	0160-2204
A1C9	0160-3443	1		CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	0160-3443
A1C10	0140-0196	3	1	CAPACITOR-FXD 150PF +-5% 300VDC MICA	72136	DM15F151J0300WV1CR
A1C11	0160-2204	0		CAPACITOR-FXD 100PF +-5% 300VDC MICA	28480	0160-2204
A1C12	0160-6041	1	10	CAPACITOR-FXD .1UF +-10% 50VDC MET/POLYE	28480	0160-6041
A1C13	0160-6041	1		CAPACITOR-FXD .1UF +-10% 50VDC MET/POLYE	28480	0160-6041
A1C14	0160-2253	9	2	CAPACITOR-FXD 6.8PF +-.25PF 500VDC CER	28480	0160-2253
A1C15				NOT ASSIGNED		
A1C16	0160-2237	9	4	CAPACITOR-FXD 1.2PF 500VDC CER	28480	0160-2237
A1C17	0160-5298	8	6	CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-5298
A1C18	0160-3670	6	4	CAPACITOR-FXD .1UF +-20% 200VDC CER	28480	0160-3670
A1C19	0160-3670	6		CAPACITOR-FXD .1UF +-20% 200VDC CER	28480	0160-3670
A1C20	0160-5298	8		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-5298
A1C21	0160-2237	9		CAPACITOR-FXD 1.2PF 500VDC CER	28480	0160-2237
A1C22	0160-6041	1		CAPACITOR-FXD .1UF +-10% 50VDC MET/POLYE	28480	0160-6041
A1C23	0160-6041	1		CAPACITOR-FXD .1UF +-10% 50VDC MET/POLYE	28480	0160-6041
A1C24	0160-2253	9		CAPACITOR-FXD 6.8PF +-.25PF 500VDC CER	28480	0160-2253
A1C25				NOT ASSIGNED		
A1C26	0160-2237	9		CAPACITOR-FXD 1.2PF 500VDC CER	28480	0160-2237
A1C27	0160-5298	8		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-5298
A1C28	0160-3670	6		CAPACITOR-FXD .1UF +-20% 200VDC CER	28480	0160-3670
A1C29	0160-3670	6		CAPACITOR-FXD .1UF +-20% 200VDC CER	28480	0160-3670
A1C30	0160-5298	8		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-5298
A1C31	0160-2237	9		CAPACITOR-FXD 1.2PF 500VDC CER	28480	0160-2237
A1C32	0160-6041	1		CAPACITOR-FXD .1UF +-10% 50VDC MET/POLYE	28480	0160-6041
A1C33	0160-6041	1		CAPACITOR-FXD .1UF +-10% 50VDC MET/POLYE	28480	0160-6041
A1C34	0160-3470	4	2	CAPACITOR-FXD .01UF +80-20% 50VDC CER	28480	0160-3470
A1C35	0160-3470	4		CAPACITOR-FXD .01UF +80-20% 50VDC CER	28480	0160-3470
A1C36	0160-3508	9	7	CAPACITOR-FXD 1UF +80-20% 50VDC CER	28480	0160-3508
A1C37	0160-3508	9		CAPACITOR-FXD 1UF +80-20% 50VDC CER	28480	0160-3508
A1C38	0160-3508	9		CAPACITOR-FXD 1UF +80-20% 50VDC CER	28480	0160-3508
A1C39	0160-3508	9		CAPACITOR-FXD 1UF +80-20% 50VDC CER	28480	0160-3508
A1C40	0160-3508	9		CAPACITOR-FXD 1UF +80-20% 50VDC CER	28480	0160-3508
A1C41	0180-0094	4	1	CAPACITOR-FXD 100UF+75-10% 25VDC AL	56289	30D107G025DD2
A1C42	0160-3508	9		CAPACITOR-FXD 1UF +80-20% 50VDC CER	28480	0160-3508
A1C43	0160-3508	9		CAPACITOR-FXD 1UF +80-20% 50VDC CER	28480	0160-3508
A1C44	0180-0197	8	6	CAPACITOR-FXD 2.2UF +-10% 20VDC TA	56289	150D225X9020A2
A1C45	0180-0197	8		CAPACITOR-FXD 2.2UF +-10% 20VDC TA	56289	150D225X9020A2
A1C46	0180-0197	8		CAPACITOR-FXD 2.2UF +-10% 20VDC TA	56289	150D225X9020A2
A1C47	0180-0197	8		CAPACITOR-FXD 2.2UF +-10% 20VDC TA	56289	150D225X9020A2
A1C48	0180-0197	8		CAPACITOR-FXD 2.2UF +-10% 20VDC TA	56289	150D225X9020A2
A1C49	0180-0197	8		CAPACITOR-FXD 2.2UF +-10% 20VDC TA	56289	150D225X9020A2
A1C50	0160-6041	1		CAPACITOR-FXD .1UF +-10% 50VDC MET/POLYE	28480	0160-6041
A1C51	0160-6041	1		CAPACITOR-FXD .1UF +-10% 50VDC MET/POLYE	28480	0160-6041
A1C52	0160-6041	1		CAPACITOR-FXD .1UF +-10% 50VDC MET/POLYE	28480	0160-6041
A1C53	0160-6041	1		CAPACITOR-FXD .1UF +-10% 50VDC MET/POLYE	28480	0160-6041
A1C54	0160-5298	8		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-5298
A1C55	0160-5298	8		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-5298
A1CR1	1901-1068	5	8	DIODE-SM SIG SCHOTTKY	28480	1901-1068
A1CR2	1901-1068	5		DIODE-SM SIG SCHOTTKY	28480	1901-1068
A1CR3	1901-1068	5		DIODE-SM SIG SCHOTTKY	28480	1901-1068
A1CR4	1901-1068	5		DIODE-SM SIG SCHOTTKY	28480	1901-1068
A1CR5	1901-1068	5		DIODE-SM SIG SCHOTTKY	28480	1901-1068
A1CR6	1901-1068	5		DIODE-SM SIG SCHOTTKY	28480	1901-1068
A1CR7	1901-1068	5		DIODE-SM SIG SCHOTTKY	28480	1901-1068
A1CR8	1901-1068	5		DIODE-SM SIG SCHOTTKY	28480	1901-1068
A1CR9	1901-0040	1	5	DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A1CR10	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A1CR11	1901-0028	5	8	DIODE-PWR RECT 400V 750MA DO-29	28480	1901-0028
A1CR12	1901-0028	5		DIODE-PWR RECT 400V 750MA DO-29	28480	1901-0028
A1CR13	1901-0096	7	4	DIODE-SWITCHING 120V 50MA 100NS	28480	1901-0096
A1CR14	1901-0096	7		DIODE-SWITCHING 120V 50MA 100NS	28480	1901-0096
A1CR15	1901-0028	5		DIODE-PWR RECT 400V 750MA DO-29	28480	1901-0028

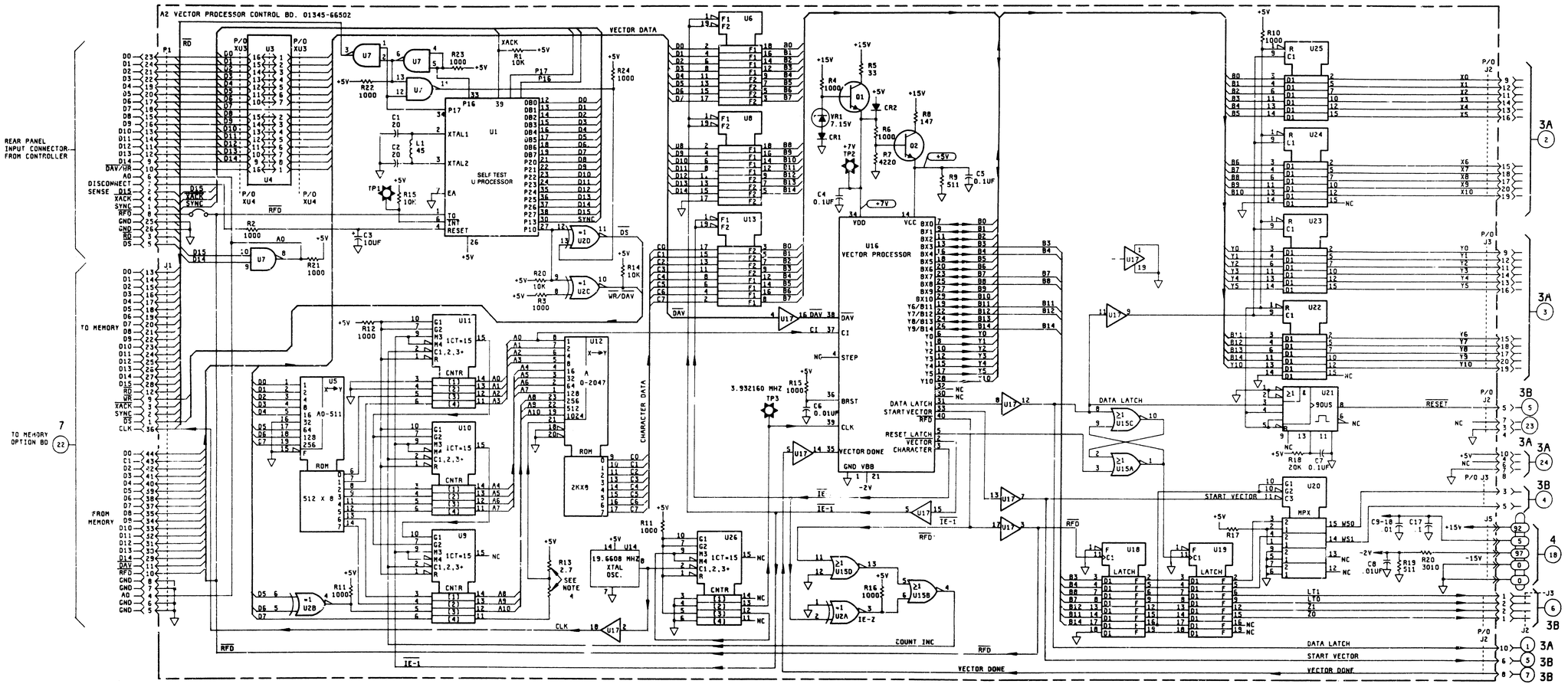
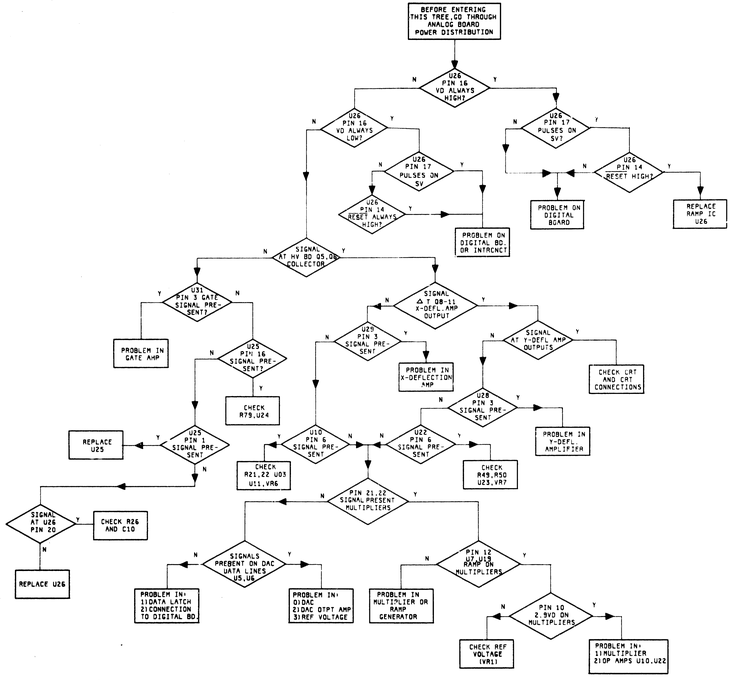
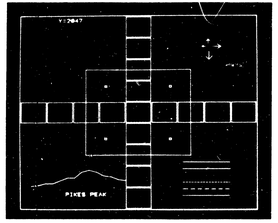


Figure 7-7.
Replacement for Service Sheets 2A and 2B.
Schematic Diagram, Vector Processor (A2) Board. Part No. 01345-66515



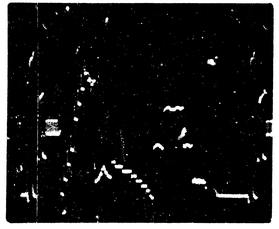
WAVEFORM MEASUREMENT CONDITION



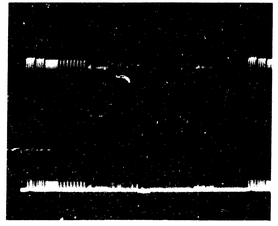
OBTAIN PRIMARY TEST PATTERN AS SHOWN ABOVE



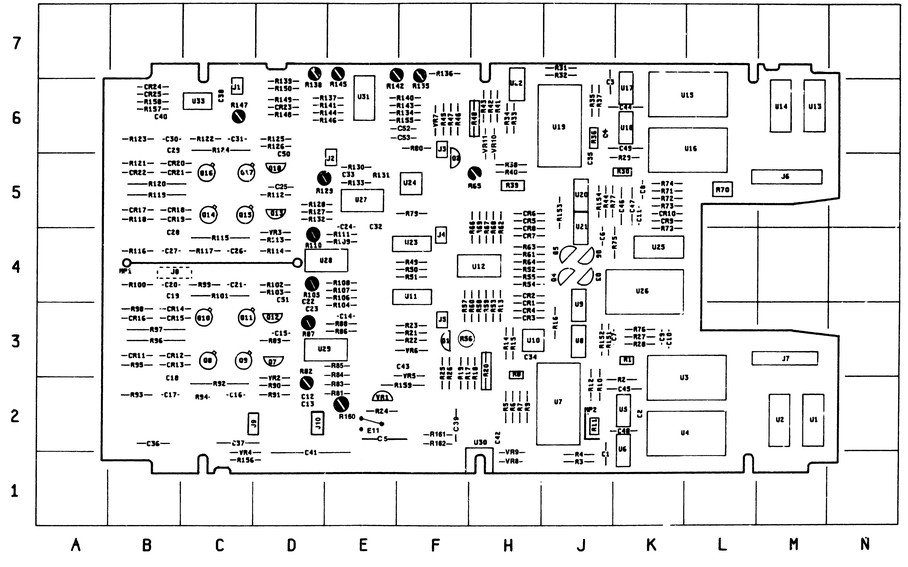
AUXILIARY X OUTPUT AT A1J5
.2 V/DIV, 2 ms/DIV



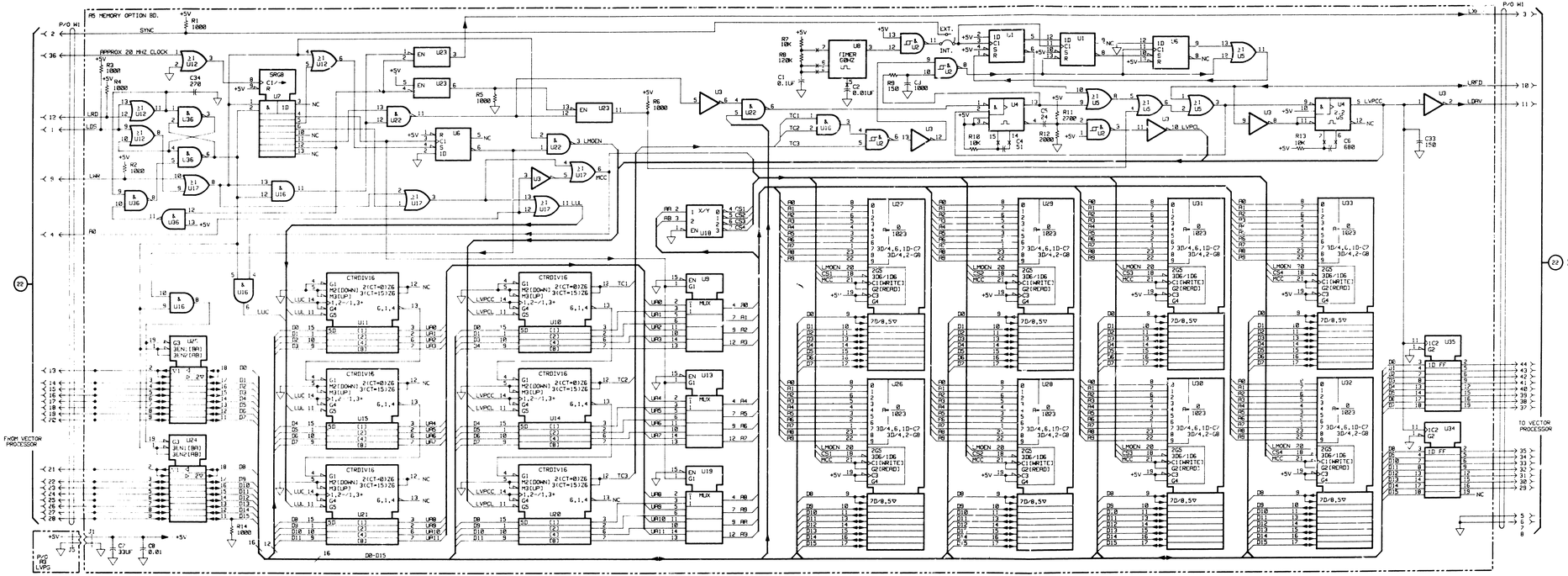
AUXILIARY Y OUTPUT AT A1J4
.2 V/DIV, 2 ms/DIV



AUXILIARY Z OUTPUT AT A1J3
.2 V/DIV, 2 ms/DIV



P/O Service Sheet 3A, X-Y-Z Amp/Stroke Generator (A1)



PARTS ON THIS SCHEMATIC	
A5	CHASSIS
C1-34 J1 R1-14 U1-36	W1

S13450101-30-84

Figure 7-8.
Replacement for Service Sheets 6A and 6B.
Schematic Diagram Memory (Option 704) (A5) Board, Part No. 01345-66525

SECTION VIII

SERVICE

8-1. INTRODUCTION.

8-2. This section provides instructions for troubleshooting and repairing the Model 1345A Digital Display.

8-3. Component locators and troubleshooting information are located opposite the schematics on foldout service sheets. The remainder of this section has general service information that should help you quickly service and repair the Digital Display.

8-4. THEORY OF OPERATION.

8-5. Overall theory of operation appears opposite the block diagram (Service Sheet 1). Each section of the diagram refers to service sheets where schematics and troubleshooting information are present. Figure 8-1 explains any unusual symbols that appear on the schematics.

8-6. LOGIC CONVENTIONS. Positive logic convention is used in this manual, unless otherwise noted on the schematics. Positive logic conventions defines a logic "1" as the more positive voltage (high) and a logic "0" as the more negative voltage (low).

8-7. LOGIC SYMBOLOGY. The new ANSI logic symbology is used in this manual. The purpose of these symbols is to graphically represent device functions so that operation can be understood without having to "look up" how a device works. Basic logic symbols and examples of symbols are shown in figure 8-2. Table 8-2 provides an explanation of function labels used in the schematics.

8-8. TROUBLESHOOTING.

WARNING

Read the safety summary at the front of this manual before troubleshooting the instrument.

8-9. INITIAL TROUBLESHOOTING PROCEDURE. Before troubleshooting the 1345A in detail, try to perform the adjustment procedures listed in Section V of this manual. Some apparent malfunctions may be corrected by these adjustments, or failure to obtain a correct adjustment will often reveal the source of trouble.

8-10. DC VOLTAGES AND WAVEFORMS. DC voltages, waveforms, and conditions for making these measurements are given on, or adjacent to schematics on the service sheets. Since conditions for making measurements may differ from one circuit to another, always check the specific conditions listed for each schematic.

8-11. RECOMMENDED TEST EQUIPMENT.

8-12. Test equipment required for maintaining the 1345A is listed in Section I, table 1-5. Equipment other than that listed may be used if it meets the listed specifications.

8-13. REPAIR.

8-14. ASSEMBLY REMOVAL. Instructions for removing major assemblies are contained in the service sheet instructions for that particular assembly. Refer to table 8-1 for the list of assemblies indexed to Service Sheets.

Table 8-1. Service Sheet Quick Reference.

Assembly	Name	Service Sheet(s)
A1	X-Y-Z- Amplifier, Stroke Generator	3A, 3B, 3C
A2	Vector Processor Control	2A, 2B
A3	Low Voltage Power Supply	4
A4	High Voltage Power Supply	5
A5	Memory (Option 704)	6A, 6B

8-15. PREVENTIVE MAINTENANCE. Painted surfaces can be cleaned with a commercial, spray-type window cleaner or with a mild soap and water solution.

CAUTION

Do not use chemical cleaning agents that might damage the plastics used in this instrument. Recommended cleaning agents are isopropyl alcohol, kelite (1 part kelite, 20 parts water), or a solution of 1% mild detergent and 99% water.

8-16. Corroded spots are best removed with soap and water. Stubborn residue can be removed with a fine abrasive. Protect such areas from further corrosion with an application of silicone resin such as GE DRIFILM 88.

REFER TO ANSI Y 32.2 FOR GRAPHIC SYMBOLS NOT LISTED IN THIS TABLE

CIRCUIT ASSEMBLY BORDERLINE

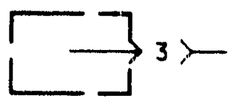
FRONT-PANEL MARKING

REAR-PANEL MARKING

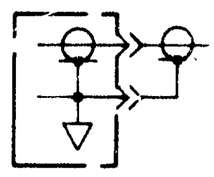
MAIN SIGNAL PATH

PRIMARY FEEDBACK PATH

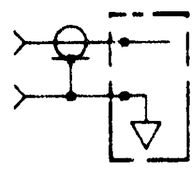
SINGLE-PIN CONNECTOR ON BOARD



PIN OF PLUG-IN BOARD OR CABLE



COAXIAL CABLE CONNECTED TO SNAP-ON JACK



COAXIAL CONNECTOR CONNECTED DIRECTLY TO BOARD



BREAKDOWN DIODE (ZENER)



SCHOTTKY (HOT-CARRIER) DIODE



STEP-RECOVERY DIODE



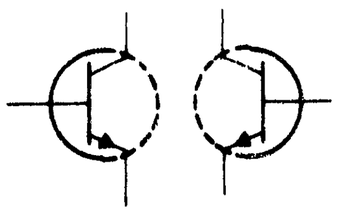
VARACTOR DIODE (VARICAP)



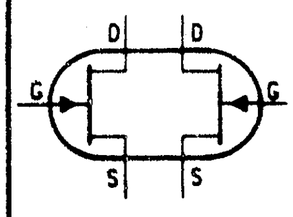
TRIAC



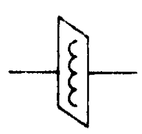
TEMPERATURE SENSOR



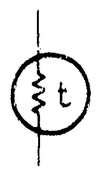
DUAL TRANSISTOR



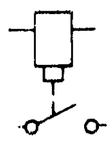
DUAL FIELD-EFFECT TRANSISTOR (N-TYPE BASE)



FERRITE BEAD



THERMISTOR



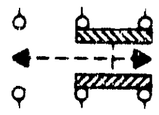
SOLENOID-ACTUATED SWITCH



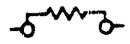
GLOW LAMP



TOROIDAL TRANSFORMER



SLIDE SWITCH



RESISTOR JUMPER

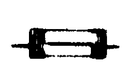


COMMON CONNECTIONS. ALL LIKE-DESIGNATED POINTS ARE CONNECTED



CHASSIS GROUND

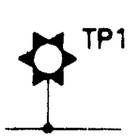
SOLDER OR MECHANICAL CONNECTION



ELASTOMERIC CONNECTOR



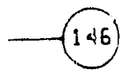
TOOL-AIDED ADJUSTMENT



NUMBERED TEST POINT. MEASUREMENT AID PROVIDED

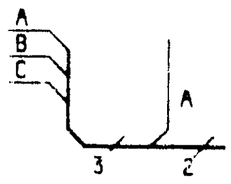


LETTERED TEST POINT. NO MEASUREMENT AID PROVIDED

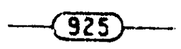


SIGNAL REFERENCE

15 SCHEMATIC REFERENCE



INDICATES MULTIPLE PATHS REPRESENTED BY ONE LINE. LETTERS OR NAMES IDENTIFY INDIVIDUAL PATHS. NUMBERS INDICATE NUMBER OF PATHS REPRESENTED BY THE LINE.



WIRE COLORS ARE GIVEN BY ENCLOSED NUMBERS USING THE RESISTOR COLOR CODE.

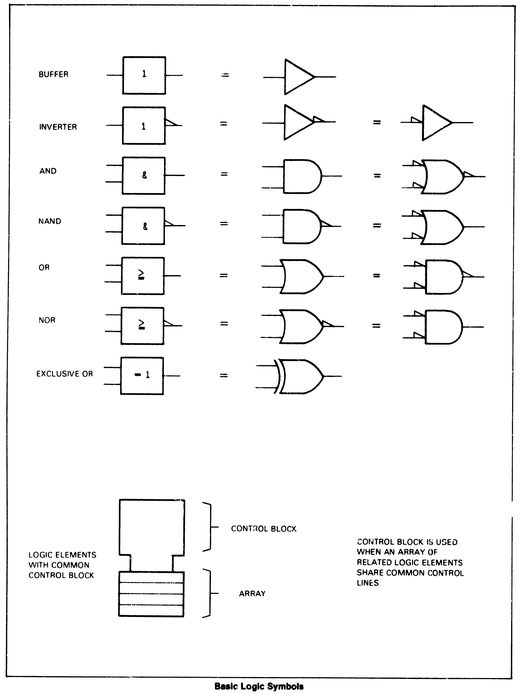
(925) IS WHT-RED-GRN

0 - BLACK	5 - GREEN
1 - BROWN	6 - BLUE
2 - RED	7 - VIOLET
3 - ORANGE	8 - GRAY
4 - YELLOW	9 - WHITE

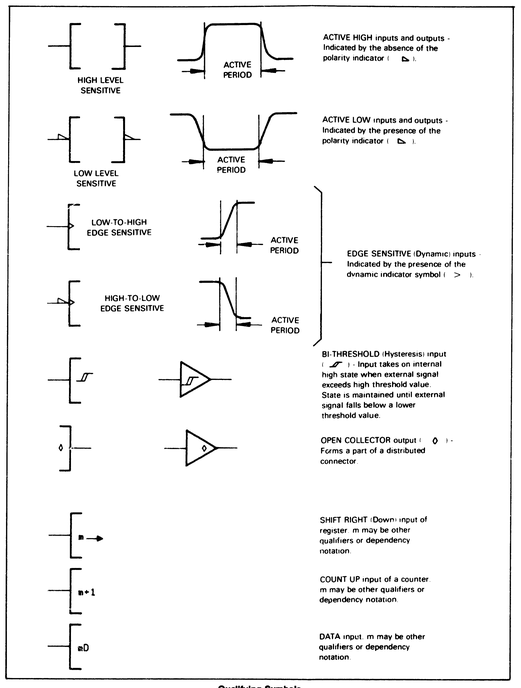
Figure 8-1. Schematic Symbols

Table 8-2. Function Labels

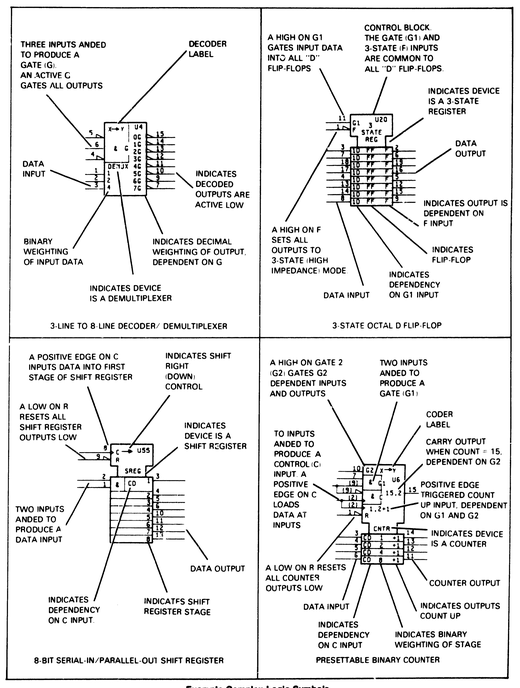
▷	AMPLIFIER/BUFFER
1 ⎍	MONOSTABLE MULTIVIBRATOR (ONE-SHOT)
&	AND GATE
≥ 1	OR GATE
= 1	EXCLUSIVE OR GATE
X→Y	ENCODER, DECODER
XMAX→Y	PRIORITY ENCODER
CNTR	COUNTER
DEMUX	DEMULTIPLEXER
FF	FLIP-FLOP
RAM	RANDOM-ACCESS MEMORY
REG	REGISTER
ROM	READ-ONLY MEMORY
SAR	SUCCESSIVE APPROXIMATION REGISTER
SEL	SELECTOR
SREG	SHIFT REGISTER
TX/RX	TRANSMITTER/RECEIVER



Basic Logic Symbols



Qualifying Symbols



Example Complex Logic Symbols

Figure 8-2. Logic Symbology

8-17. PRINCIPLES OF OPERATION.

8-18. INTRODUCTION.

The simplified block diagram (figure 8-5) shows the major functional stages of the 1345A, and their respective service sheets. The theory of operation of each stage is described below.

8-19. VECTOR PROCESSOR CONTROL BOARD (Assembly A2, Service Sheets 2A, 2B).

The purpose of the Vector Processor Control is to convert the digital 16 bit input data to absolute coordinate vector data for the Stroke Generator (A1). This is accomplished by interfacing a host processor or refresh memory system with the circuit board. The Self-Test microprocessor (A2U1) is used for storing the primary and secondary test pattern and initiating the power up test. The patterns are used for the Performance Checks (Section IV) and the Adjustment procedures (Section V). The Vector Processor Control Board contains the following primary circuits:

1. Input Data Latches (A2U6, A2U8, A2U13).
2. Output Data Latches (A2U22-A2U25).
3. Character Generator (A2U5, A2U9, A2U10, A2U11, A2U12).
4. Timing Circuits (A2U14, A2U26).
5. Vector Processor (A2U16).

INPUT DATA BUFFERS. The Input Data Buffers provide buffering for the Vector Processor (A2U16). The input data is held in these buffers until the VPC is ready for new vector data. Character data is handled by A2U13, while vector data is handled by A2U6 and A2U8. The VPC controls the latching of the data by using the signal lines LVECTOR and LCHARACTER.

OUTPUT DATA LATCHES. The absolute X and Y vector values generated by the VPC (A2U16), are held in output latches A2U22-A2U25 for use by the Stroke Generator. The vector data is transferred by the Data Latch signal into the Output Latches Control Latches (A2U18-A2U20) contain the last Set Condition commands.

CHARACTER GENERATOR. The Character Generator translates character data into vector data for the VPC. ROM A2U12 contains a look-up table with the stroke information for the modified ASCII character set (see table 3-1 for list of characters). The character size and rotation is processed by the VPC for proper vector generation.

TIMING CIRCUIT. The clock circuit (A2U14,A2U26) provides two clock frequencies. A2U14 generates the 19.66 MHz signal which is divided by 5 to generate the required 3.93 MHz clock for the VPC.

VECTOR PROCESSOR (VPC). The VPC is the controlling device for vector generation, using four programmable modes of operation. Each of the commands that the 1345A can recognize is selected by the state of data bits B14 and B13. Data bit B15 is used only for memory board operation. It is always 0 when the memory board is not installed.

1. Set Condition
2. Plot Absolute
3. Graph Absolute
4. Text

SET CONDITION. When the Most Significant Bits of an input word (B14, B13), are set to "1", the VPC recognizes the Set Condition Command. The Set Condition Command controls the intensity level, the line type, and the writing speed of the vector drawn. Once a Set Condition has been defined, the data remains stored in latches A2U18-A2U20 until a new Set Condition Command is received.

PLOT COMMAND. When the Most Significant Bits (B14,B13) are set to "0", the VPC is ready to process vector data. Data bits B0-B10 define X or Y coordinates. When bit B12 is set to "0" the incoming data is an X coordinate, when bit B12 is set to "1" the incoming data is a Y coordinate. The beam can be turned on or off depending on the status of bit B11. The present X-Y coordinates are latched into A2U22-A2U25.

GRAPH COMMAND. The Graph Command allows automatic X incrementing with each new Y coordinate input. To invoke the Graph Command, data bit B14 must be set to "0" and B13 must be set to "1". When bit B12 is set to "0", B0-B10 define the X increment. The VPC is now programmed to increment the X coordinate each time a new Y coordinate is received. Bits B0-B10 contain Y coordinate information when B12 is set to "1".

TEXT COMMAND. When bits B14 is set to "1" and B13 is set to "0", the VPC is instructed to go to the Text Mode. Bits B0-B7 define the character to be drawn. B11-B12 define the size of character to be drawn, B9-B10 determine rotation of the character. When bit B8 is set to "0" the VPC defaults to the previous size and rotation data. When set to "1" size and rotation information is determined via data bits B9-B12.

8-20. STROKE GENERATOR AND X-Y OUTPUT AMPLIFIERS (Assembly A1, Service Sheets 3A, 3B, 3C).

8-21. STROKE GENERATOR. The Stroke Generator converts binary data to analog deflection information. The Stroke Generator consists of the following primary circuits.

1. Digital to Analog Converters (A1U3, A1U4, A1U15, A1U16)
2. Analog Multiplier (A1U7, A1U19)
3. Ramp Generator (A1U26)
4. Intensity Controller (A1U25)

The X and Y Stroke Generator circuits are identical, therefore only the X Stroke Generator will be described below.

DIGITAL TO ANALOG CONVERTER. A1U1 and A1U2 latch the previous X coordinate for comparison with the present X coordinate data. A1U3 and A1U4 are 12 bit DACs that convert the binary coordinate data to a corresponding analog current. The voltage output of operational amplifiers A1U5 and A1U6 represents the present and previous X coordinates. The difference between these two voltages determines the next relative beam movement in the X direction.

ANALOG MULTIPLIER. The Analog Multiplier multiplies two signals. The ramp generated by A1U26 and the DAC outputs are multiplied. The output of A1U10 is a ramp whose amplitude is a function of the desired relative X beam movement and whose offset is a function of screen location (see figure 8-3).

RAMP GENERATOR. The Ramp Generator (A1U26) provides two signals: a ramp for X-Y beam movement and the gate pulse for beam blanking. In order to maintain a constant intensity level for different vector length, the slope of the ramp (writing speed) must be held constant. The ramp slope is controlled by a combination of four inputs to A1U26. (See figure 8-4 for the current definitions).

INTENSITY CONTROLLER. The Intensity Controller converts digital line, writing and intensity information to analog voltages for use by the Intensity Amplifier. The only other input to the Intensity Controller is the gate pulse for beam blanking generated by A1U26.

8-22. X-Y AMPLIFIERS (Assemblies A1, A4, Service Sheets 3C, 5).

The X and Y amplifiers are identical. They amplify the X and Y analog coordinates from the Analog Multiplier (A1U7, A1U19) to drive the CRT horizontal and vertical deflection plates. Since both amplifiers are identical, only the X amplifier will be described below.

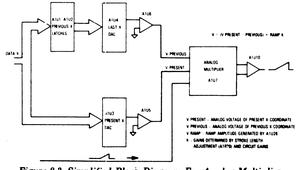


Figure 8-3. Simplified Block Diagram For Analog Multiplier

The X amplifier consists of a preamplifier (A1U29) and an output amplifier (A1Q7-A1Q12). The differential output from preamp A1U29 is applied to two identical amplifiers A1Q7-A1Q9 and A1Q10-A1Q12. The signal voltage is raised by these two amplifiers to the required level to drive the horizontal deflection plates. The gain of the output amplifier is stabilized by the negative feedback path through A1R92 and A1R101. The gain and balance of the X amplifier is set by A1R87 and A1R82 respectively.

8-23. Z-AXIS AMPLIFIER (Assemblies A1, A4, Service Sheets 3C, 5).

The operating potential between the CRT grid and cathode is controlled by the Z-Axis amplifier output level. The amplifier consists of the Z-Axis preamp located on the Stroke Generator assembly (A1) and the Intensity Amplifier located on the High Voltage Power Supply assembly (A4). The output of the preamp A1U27 is applied to the Focus Correction amplifier (A1U31) and the Intensity Amplifier A4Q4-A4Q6. The output of emitter follower A4Q4 is applied to amplifier A4Q5 and A4Q6 where the signal amplitude is raised to the required level to control the operating potential of the CRT control grid. Intensity Amplifier gain is stabilized by the negative feedback path through A4R11. A4CR5 and A4CR6 provide protection for the Intensity Amplifier output stage against arcs and transients.

8-24. FOCUS CORRECTION AMPLIFIER (Assemblies A1, A4, Service Sheets 3C, 5).

The Focus Correction circuit provides an optimum focused display over the entire viewing area. The amplifier uses three inputs for proper focus correction voltage generation. A voltage proportional to the beam position is coupled from the X and Y preamps to A1U31D and A1U31A. The Z axis correction voltage is fed from the Z axis preamp to the output of A1U31B. The X Gain and Balance is adjusted by A1R142 and A1R135, the Y Gain and Balance is adjusted by A1R145 and A1R138. The focus correction signal is applied to Focus Output amplifier A4Q1-A4Q3. The Output amplifier operates identical to the Intensity Amplifier.

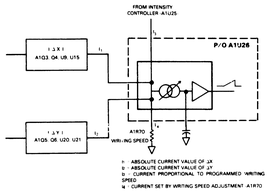


Figure 8-4. Current Definition For Ramp Generator

8-25. LOW AND HIGH VOLTAGE POWER SUPPLIES. (Assemblies A3, A4, Service Sheets 4, 5).

8-26. LOW VOLTAGE POWER SUPPLY. The Low Voltage Power Supply consists of only one primary circuit—the +105 V supply. All other required operating supplies must be provided by an external supply (see table 1-1, Input Power Requirements). The +105 V power supply is a switching supply consisting of A3U1, A3Q1, A3Q2, and A3T1. A3U1 contains all the functions necessary for current limiting, regulating, and switching the power transistors A3Q1 and A3Q2. A3C5 and A3R4 determine the switching frequency of the oscillator A3U1. A3T1 steps up the switching voltage. A3CR3 and A3CR4 make up the rectifier. Filtering is accomplished by A3L2 and A3C7. A3R10 adjusts the +105 V supply.

8-27. HIGH VOLTAGE POWER SUPPLY. The High Voltage Power Supply provides the high operating potentials for the CRT. The supply consists of the following primary circuits: an oscillator, the cathode rectifier and filter circuit; a regulator circuit and the level translator. The oscillator signal is stepped up by transformer A4T1 and rectified by A4CR11. A4C12, A4C13 and A4R32 provide filtering for the cathode supply. A4R33 and A4U1 make up the regulator circuit. The feedback voltage from A4R33 is compared to the +105 V reference voltage at the junction of A4R21 and A4R33. The resultant output voltage of A4U1 controls the amplitude of the High Voltage Oscillator A4Q7. The Level Translator, A4CR14 and A4CR15, establishes the operating potential between cathode and grid of the CRT.

8-28. MEMORY CIRCUIT, OPTION 704 (Assembly A5, Service Sheets 6A, 6B).

NOTE

When Memory Option Board is installed Jumper Packs A2U3 and A2U4 must be removed.

The Vector Memory option functions as an auxiliary vector data storage for the display (static 4Kx16 bit), and provides a means for automatic display refresh in order to "free up" the controller.

8-29. MEMORY CONTROL (Service Sheet 6A).

The Memory Control section interprets the user commands and synchronizes the memory operations. The circuit is divided into three functional stages: The Command Decode stage, the Memory Control Latch and the Memory Control Circuitry.

THE COMMAND DECODER. The Command Decoder monitors the status of the memory operations. The user commands (LRD, LWR, LDS) and the memory status lines specify in which of the two modes the memory is to operate. The two states are: Read/Write and Screen Refresh. To read data from memory, control lines LDS and LRD are used. To write data into memory, control lines LDS and LWR are used. When control line LDS is set high by the user, the display will be refreshed at the sync rate according to the instructions stored in memory. Internal Sync is generated by the 60 Hz clock A5U25 and A5U28, unless held-off by LCLR SYNC being set low. LCLR SYNC will also hold off the LMAX ADDR line. The LMAX ADDR line indicates when the end of the display memory is reached. When User Data lines UD14 and UD15 are high, SET ADDRS is set low indicating that the Read/Write pointer is to be sent to the address defined by UD0 through U.11. USER ADDRS CLOCK clocks the status of the user commands through A5U26 to A5U29. The output at A5U29 pin 3 (LXACK) is fed back to the user to acknowledge that the command has been received.

REFRESH SYNC. The display refresh is synchronized by either an internal clock or by an external sync signal provided by a user clock.

INTERNAL SYNC. When in Internal Sync mode, an onboard oscillator (A5U25) provides sync pulses at approximately a 60 Hz rate. The user processor can send all picture producing data to the Vector Memory at one time. The Vector Memory will then continuously refresh the display screen by redrawing the picture at regular intervals. This reduces overhead time for the user processor.

EXTERNAL SYNC. Sync pulses (TTL) must be supplied from an external source in the user system via the SYNC input signal line at W1 pin 4.

MEMORY CONTROL LATCH. On the positive edge of the 22 MHz oscillator (Y1), the status of the five state request line and the two status signals are latched into A5U39. These seven control lines along with the XOR of LRD and LWR are then held at the Memory Control circuitry inputs MCA0-MCA7. The five state request signals are: LWR+LDS, LRD+LDS, SET ADDR, RFD, and MD15. The two status signals are LMAX ADDR and SYNC.

MEMORY CONTROL CIRCUITRY. The output of the Memory Control devices (A5U15, A5U16) are the twelve memory control signals and the four state control signals. The Memory Control signals are: VPC ADDRS LOAD, VPC ADDRS CLOCK, VPC DATA LATCH CLOCK, USER ADDRS LOAD, USER ADDRS CLOCK, USER WRITE LATCH CLOCK, USER WRITE LATCH ENABLE, USER READ LATCH CLOCK, USER READ LATCH ENABLE, VM ADDRS MUX (H=USER/L=VPC ADDRESS SELECT), VM LOE, and VM LWE. The four state control signals are: MCA8, MCA9, MCA10, and MCA11. The states of the Memory Control signals are determined by the data stored in the Memory Control devices (A5U15, A5U16). The Memory Control Address specified by MCA0-MCA11 will, at the positive edge of the control clock, determine the state of the Memory Control Signals.

MEMORY CIRCUIT (Service Sheet 6B).

The following circuit description refers to the two modes of operation of the memory circuit: The Read/Write mode and the Screen Refresh mode.

READ/WRITE MODE. The user can do a Read/Write operation without setting the Read/Write Pointer. However, it is recommended that the user know which location in memory is being accessed (read from or written into). There are two steps in a read or write operation: Setting the Read/Write Pointer, and read from or write into Vector Memory.

SET POINTER. The value in the Read/Write Pointer specifies the next address in Vector Memory that will be written into or read from by the user processor. When the user sends a Set Pointer Command, the USER ADDRS LOAD line is set low and the data specified by bits MD0-MD12 is preloaded into the Read/Write Pointer. The outputs of the Pointer (USER A0-USER A12) are selected by the Address Multiplexers (A5U1, A5U4, A5U19, A5U22) as the next memory address.

READ/WRITE. After the vector memory address has been selected, a Read/Write operation can be performed. To read data from Vector Memory, the user sets LDS and LRD lines low. Control line VM LOE will set low and the information at the address specified will be placed on the Data Bus. During the time that LDS and LRD are low, the Memory Read Latches (A5U12, A5U38) are enabled to transfer the data from the Memory Data Bus to the User Data Bus (UD0-UD15).

When a write operation is performed, signal lines LDS and LWR are set low, and LRD is set high. As a result, the VM LWE line is set low and the information on the Data Bus is written into Vector Memory at the address specified. The data flow through the memory write latches (A5U13, A5U36) is controlled by the USER WRITE LATCH ENABLE line. When this line is low, data is transferred from the User Data Bus to the Memory Data Bus.

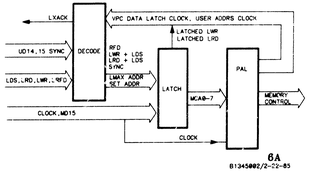


Figure 8-5. Read/Write Mode.

REFRESH MODE. The refresh sync signal may be provided by either the internal refresh circuit, or any external source. To select the required mode of operation, move jumper resistor (A5R6) to EXT or INT as necessary.

The VPC ADDRS LOAD, VPC ADDRS CLOCK, and VPC DATA LATCH CLOCK control the memory address and therefore the data transfer to the VPC circuit during screen refresh. The rate of data transfer is controlled by the LRFD and LDAV handshake rate. VM ADDRS MUX is low during this operation.

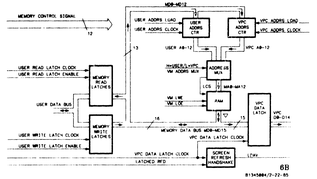
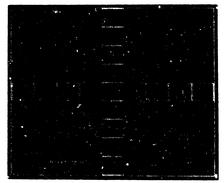


Figure 8-6. Picture Refresh Mode

WAVEFORM MEASUREMENT CONDITION



OBTAIN PRIMARY TEST PATTERN AS SHOWN ABOVE

NOTE:

WAVEFORM MEASUREMENTS TAKEN WITHOUT MEMORY CIRCUIT INSTALLED.



TOP LRFD A2, U17 PIN 3
BOTTOM: LDAV A2, U17 PIN 4



TOP: A4, PIN 7
BOTTOM: A3, Q1 COLLECTOR



Y DAC OUTPUT
.05 V/DIV, 2 ms/DIV



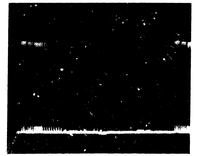
XDAC OUTPUT
.05 V/DIV, 2 ms/DIV



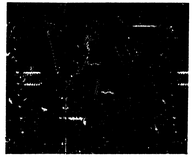
AUXILIARY X OUTPUT AT A1J5
.2 V/DIV, 2 ms/DIV



AUXILIARY Y OUTPUT AT A1J4
.2 V/DIV, 2 ms/DIV



AUXILIARY Z OUTPUT AT A1J3
.2 V/DIV, 2 ms/DIV



X OUTPUT AT A1Q8 COLLECTOR
(TO HORIZONTAL CRT DEFLECTION PLATES)
10 V/DIV, 2 ms/DIV



Y OUTPUT AT A1Q14 COLLECTOR
(TO VERTICAL CRT DEFLECTION PLATES)
10 V/DIV, 2 ms/DIV

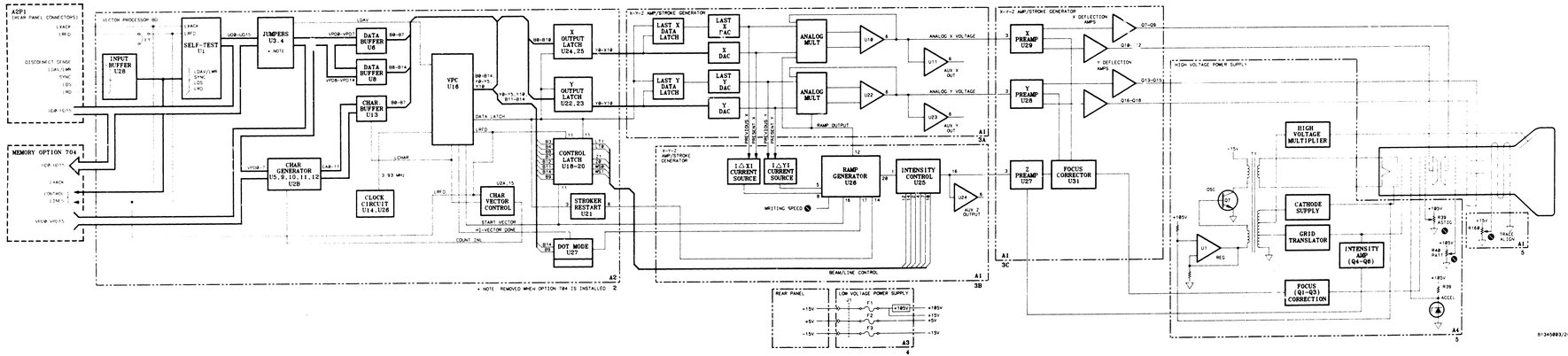
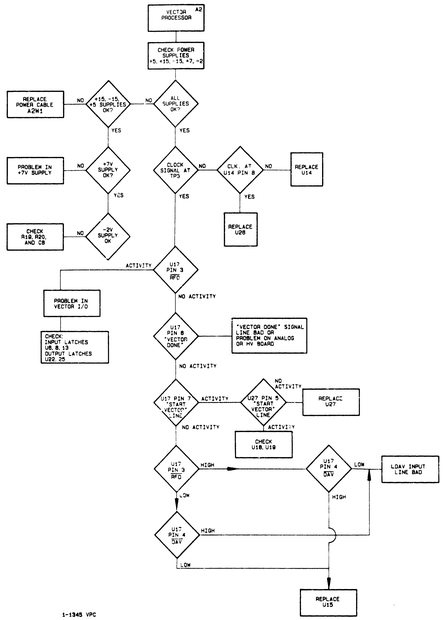
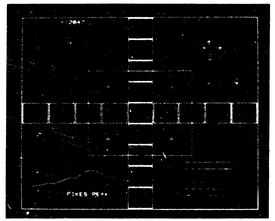


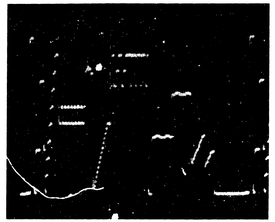
Figure 8-7.
Service Sheet 1, Block Diagram



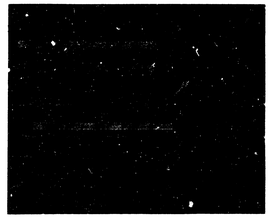
WAVEFORM MEASUREMENT CONDITION



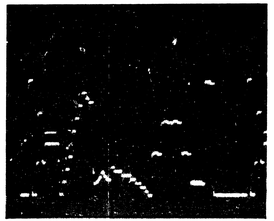
OBTAIN PRIMARY TEST PATTERN AS SHOWN / BOVE



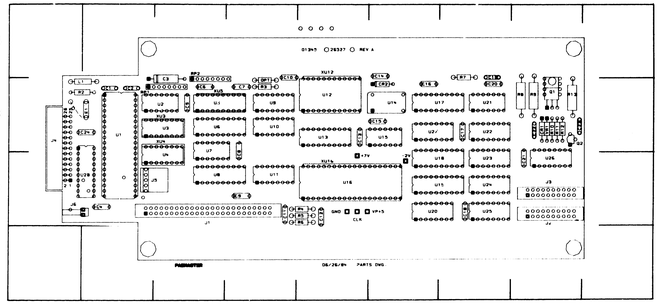
X DAC OUTPUT
.05 V/DIV, 2 ms/DIV



TOP: RFD A2, U17 PIN 3
BOTOM: DAV A2, U17 PIN 4

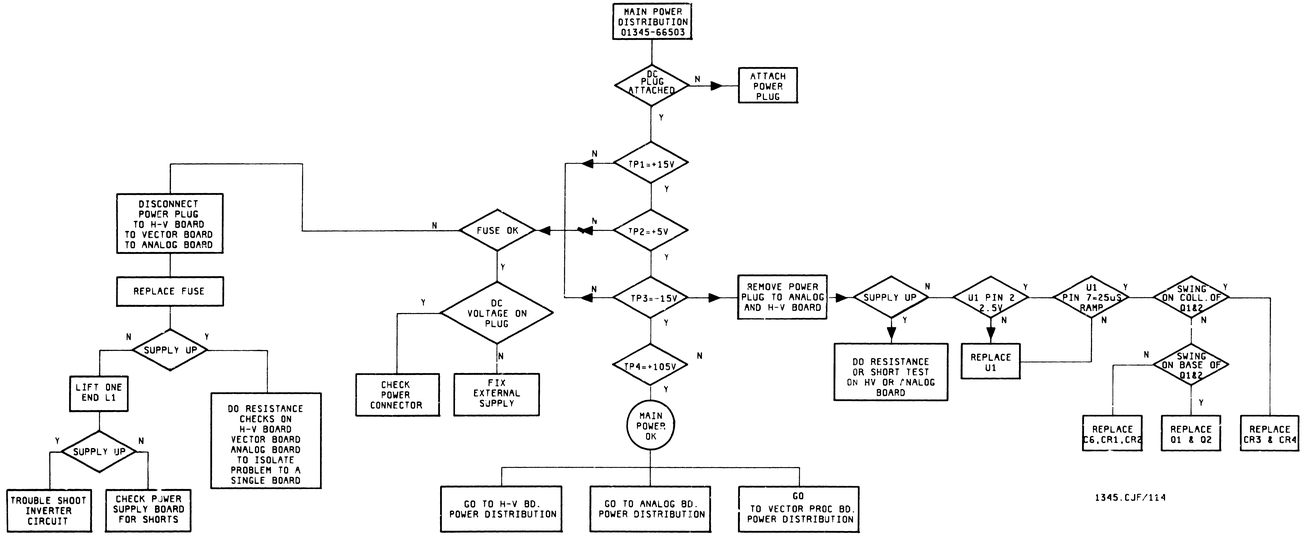


Y DAC OUTPUT
.05 V/DIV, 2 ms/DIV

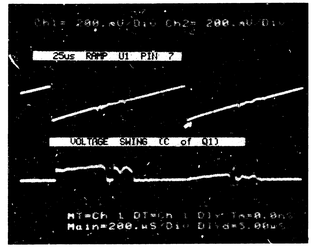


REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC
C1	B-3	C21	G-2	R6	D-1	U11	D-2
C2	B-3	C22	H-3	R7	G-3	U12	E-3
C3	B-3	C23	H-3	R8	G-3	U13	E-3
C4	A-2	C24	A-3	R9	H-3	U14	F-3
C5	C-3	CR1	H-2	R10	H-3	U15	E-3
C6	C-3	CR2	E-3	R11	H-3	U16	E-2
C7	C-3	E1	A-3	R12	H-3	U17	F-3
C8	C-2	J1	C-2	R13	H-3	U18	F-2
C9	C-2	J2	H-2	RP1	B-3	U19	F-2
C10	D-3	J3	H-2	RP2	C-3	U20	F-2
C11	D-2	J4	A-3	U1	B-3	U21	G-3
C12	E-2	J5	B-2	U2	B-3	U22	G-3
C13	E-3	J6	A-2	U3	B-3	U23	G-2
C14	E-3	L1	A-3	U4	B-2	U24	G-2
C15	E-3	Q1	H-3	U5	C-3	U25	G-2
C16	F-3	Q2	H-3	U6	C-3	U26	H-2
C17	G-3	R2	A-3	U7	C-2	U27	F-3
C18	G-2	R3	D-3	U8	C-2	U28	A-2
C19	G-3	R4	D-2	U9	D-3	VR1	H-3
C20	G-3	R5	D-2	U10	D-3		

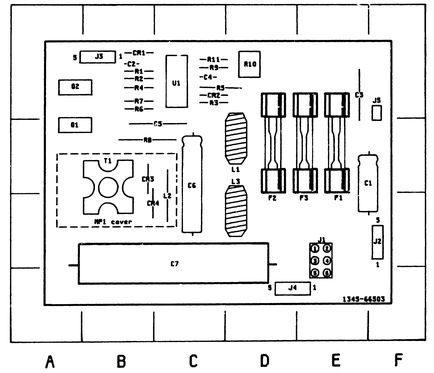
P/O Service Sheet 2, Vector Processor (A2)



1345.CJF/114

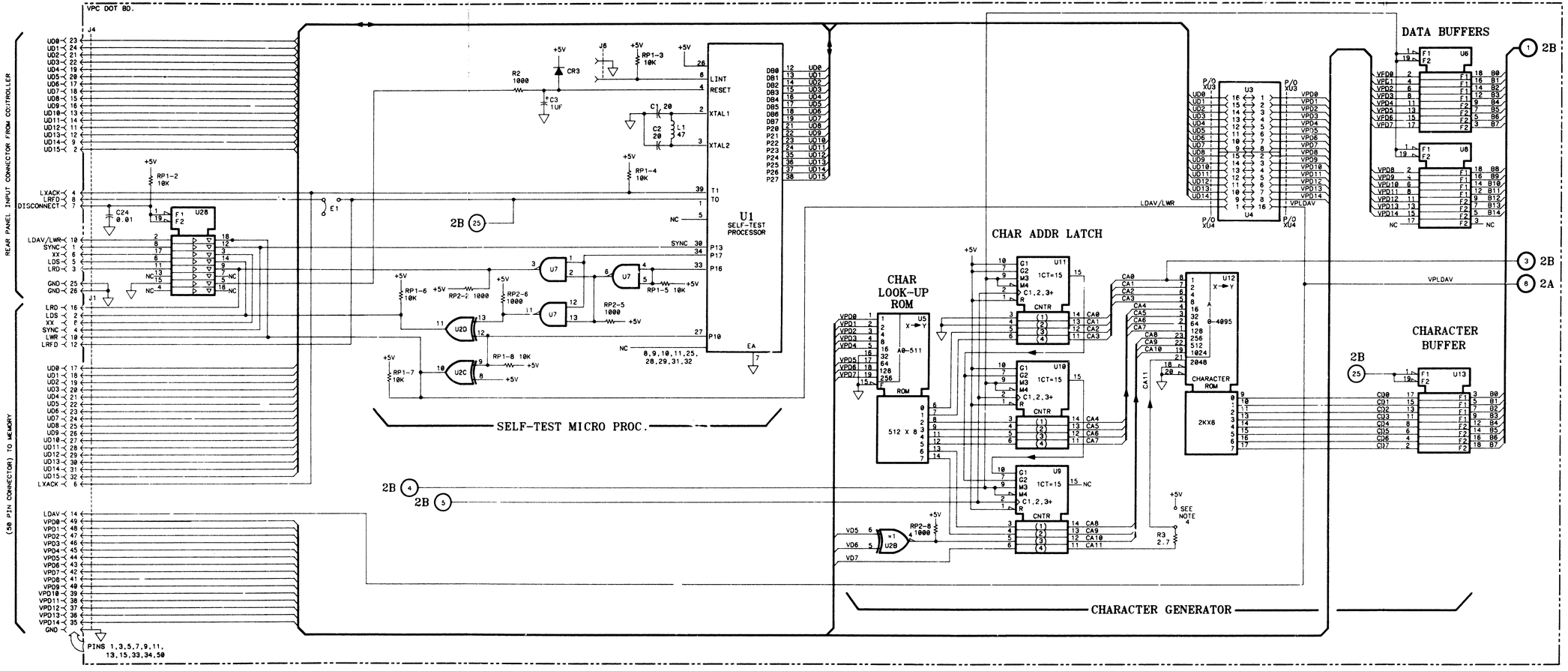


TOP: OSCILLATOR SIGNAL AT A3U1, PIN 7
BOTTOM: COLLECTOR OF A3Q1

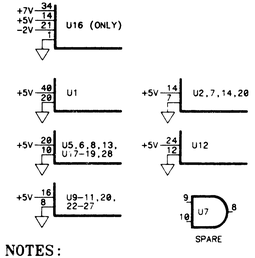


REF DESIG	GRID LOC	REF DESIG	GRID LOC
C1	E-3	L1	D-3
C2	B-4	L2	C-3
C3	E-4	L3	D-3
C4	C-4	MP1	B-2
C5	C-3	Q1	A-3
C6	C-3	Q2	A-2
C7	C-2	R1	B-4
CR1	B-4	R2	B-4
CR2	C-4	R3	C-4
CR3	B-3	R4	B-4
CR4	B-2	R5	C-4
F1	E-2	R6	B-4
F2	D-2	R7	B-4
F3	E-2	R8	B-3
J1	E-2	R9	C-4
J2	E-2	R10	D-4
J3	B-4	R11	C-4
J4	D-1	T1	B-3
J5	F-4	U1	C-4

P/O Service Sheet 4, Low Voltage Power Supply (A3)



IC DEVICE POWER CONNECTIONS



NOTES:

1. GATES ARE SYMBOLIZED ACCORDING TO CIRCUIT FUNCTION.
2. UNLESS OTHERWISE NOTED: RESISTANCE IN OHMS CAPACITANCE IN PICOFARADS INDUCTANCE IN MICROHENRIES
3. UNLESS OTHERWISE NOTED: LOGIC LEVELS ARE TTL: +2.0V TO +5.0V=LOGIC"1"=H 0V TO +0.8V=LOGIC"0"=L
4. R3 SHOWN IN POSITION FOR 32K ROM. USE ALTERNATE POSITION FOR 16K ROM.
5. WHEN MEMORY IS INSTALLED, JUMPERS U3 & U4 MUST BE REMOVED.
6. JUMPER E1 SHOWN "MEMORY INSTALLED". ALTERNATE POSITION IS FOR NO MEMORY.

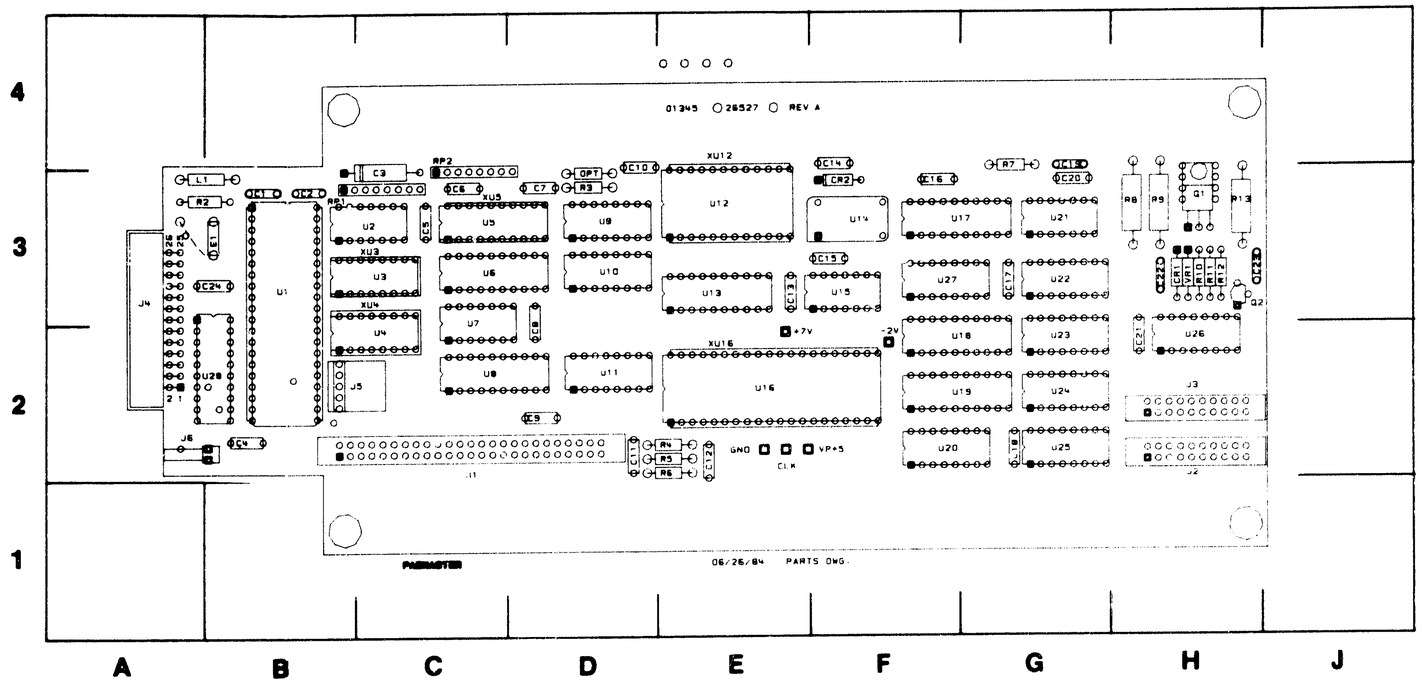
PARTS ON THIS SCHEMATIC

C1-3,24
CR3
E1
J1,4,6
R2,3
RP1,2
U1-8,10-13,28

S1345014/2-20-1985

SERVICE SHEET 2A

Figure 8-8.
Service Sheet 2, Vector Processor (A2)



REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC
C1	B-3	C21	G-2	R6	D-1	U11	D-2
C2	B-3	C22	H-3	R7	G-3	U12	E-3
C3	B-3	C23	H-3	R8	G-3	U13	E-3
C4	A-2	C24	A-3	R9	H-3	U14	F-3
C5	C-3	CR1	H-3	R10	H-3	U15	E-3
C6	C-3	CR2	E-3	R11	H-3	U16	E-2
C7	C-3	E1	A-3	R12	H-3	U17	F-3
C8	C-2	J1	C-2	R13	H-3	U18	F-2
C9	C-2	J2	H-2	RP1	B-3	U19	F-2
C10	D-3	J3	H-2	RP2	C-3	U20	F-2
C11	D-2	J4	A-3	U1	B-3	U21	G-3
C12	E-2	J5	B-2	U2	B-3	U22	G-3
C13	E-3	J6	A-2	U3	B-3	U23	G-2
C14	E-3	L1	A-3	U4	B-2	U24	G-2
C15	E-3	Q1	H-3	U5	C-3	U25	G-2
C16	F-3	Q2	H-3	U6	C-3	U26	H-2
C17	G-3	R2	A-3	U7	C-2	U27	F-3
C18	G-2	R3	D-3	U8	C-2	U28	A-2
C19	G-3	R4	D-2	U9	D-3	VR1	H-3
C20	G-3	R5	D-2	U10	D-3		

P/O Service Sheet 2, Vector Processor (A2)

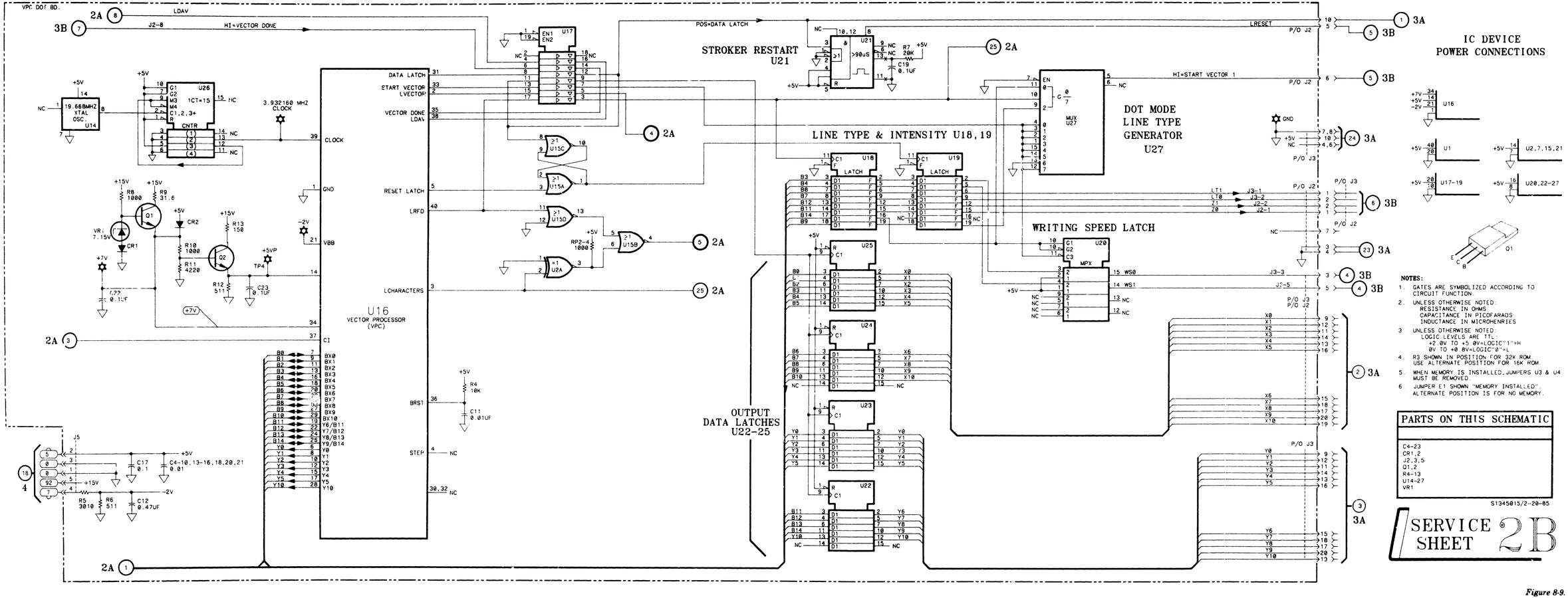
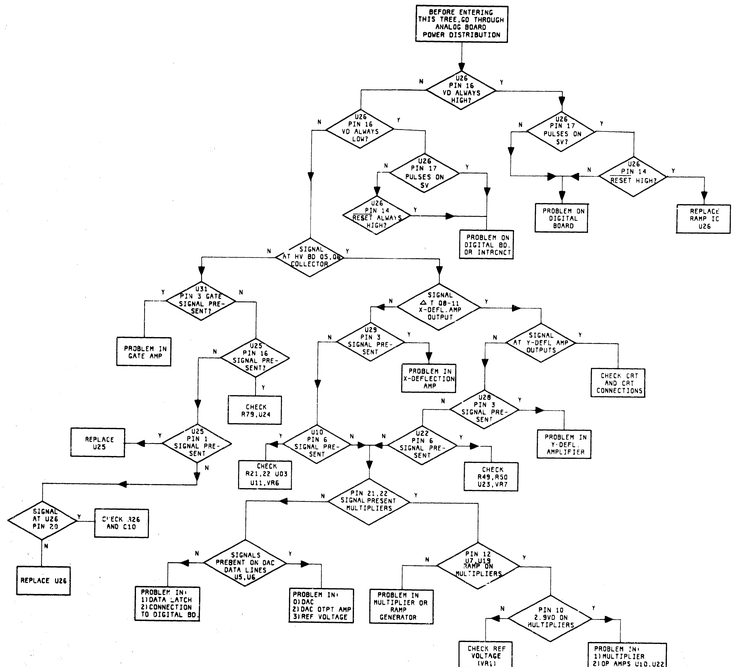
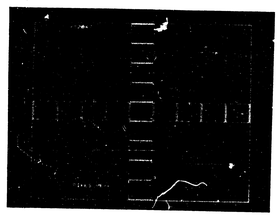


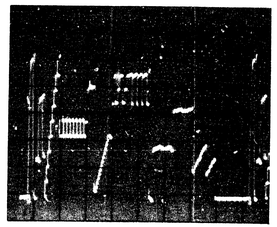
Figure 8-9.
P/O Vector Processor (A2)



WAVEFORM MEASUREMENT CONDITION

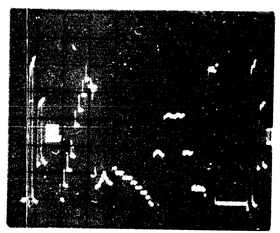


OBTAIN PRIMARY TEST PATTERN AS SHOWN ABOVE

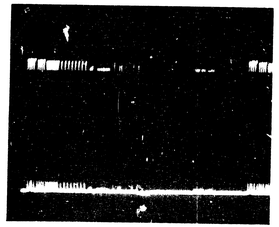


AUXILIARY X OUTPUT AT A1J5
.2 V/DIV, 2 ms/DIV

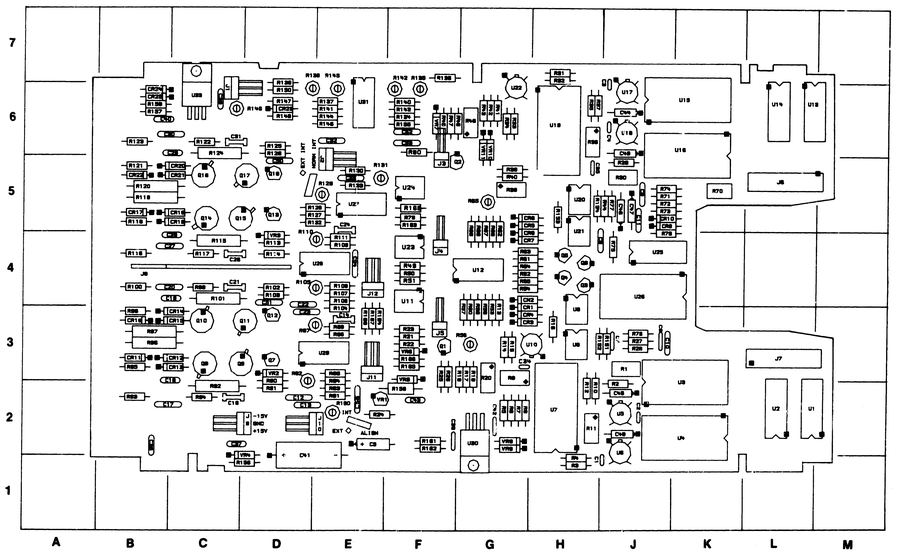
NOTE:
WAVEFORM MEASUREMENTS TAKEN WITHOUT MEMORY CIRCUIT INSTALLED.



AUXILIARY Y OUTPUT AT A1J4
.2 V/DIV, 2 ms/DIV

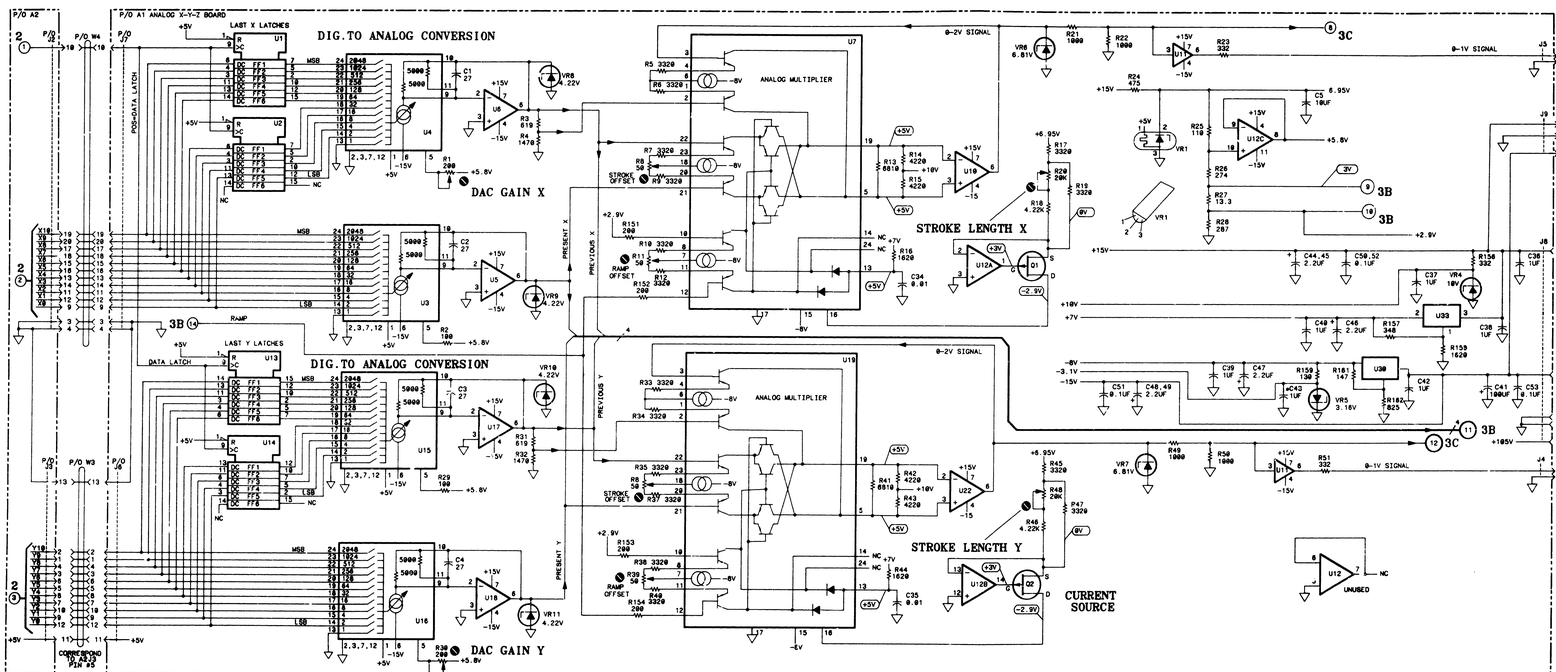


AUXILIARY Z OUTPUT AT A1J3
.2 V/DIV, 2 ms/DIV



P/O Service Sheet 3A, X-Y-Z Amp/Stroke Generator (A1)

REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC
C1	H-1	C48	J-2	Q1	F-3	R29	J-5	R75	J-4	R123	B-6	R168	E-3
C2	J-2	C49	J-6	Q2	F-5	R30	J-5	R76	J-3	R124	C-6	R169	F-5
C3	J-7	C50	D-5	Q3	H-4	R31	H-7	R77	J-5	R125	D-6	U1	L-2
C4	J-6	C51	D-4	Q4	H-4	R32	H-7	R78	J-4	R126	D-6	U2	L-2
C5	E-2	C52	F-6	Q5	H-4	R33	G-6	R79	F-5	R127	D-5	U3	K-2
C6	H-4	C53	F-6	Q6	H-4	R34	G-6	R80	F-6	R128	D-5	U4	K-2
C7	J-3	C54	E-4	Q7	D-3	R35	H-6	R81	E-2	R129	E-5	U5	J-2
C8	J-5	C55	E-2	Q8	C-3	R36	H-6	R82	D-2	R130	E-5	U6	J-2
C9	J-3	CR1	G-3	Q9	C-3	R37	H-6	R83	E-2	R131	E-5	U7	H-2
C10	J-3	CR2	G-4	Q10	C-3	R38	G-5	R84	E-2	R132	D-5	U8	H-2
C11	J-5	CR3	G-3	Q11	C-3	R39	G-5	R85	E-3	R133	E-5	U9	H-3
C12	D-2	CR4	G-2	Q12	D-3	R40	G-5	R86	E-3	R134	E-6	U10	G-3
C13	D-2	CR5	G-5	Q13	D-5	R41	G-6	R87	D-3	R135	F-6	U11	F-4
C14	E-3	CR6	G-5	Q14	C-5	R42	G-6	R88	E-3	R136	F-7	U12	G-4
C16	C-2	CR7	G-4	Q15	C-5	R43	G-6	R90	D-2	R137	E-6	U13	L-6
C17	B-2	CR8	G-4	Q16	C-5	R44	H-5	R91	D-2	R138	D-6	U14	L-6
C18	B-2	CR9	J-5	Q17	C-5	R45	F-6	R92	C-2	R139	D-7	U15	K-6
C19	B-4	CR10	J-5	Q18	D-5	R46	F-6	R93	B-2	R140	F-6	U16	K-6
C20	B-4	CR11	B-3	R1	J-3	R47	F-6	R94	C-2	R141	E-6	U17	J-6
C21	C-4	CR12	C-3	R2	J-2	R48	G-5	R95	B-3	R142	F-6	U18	J-6
C22	B-4	CR13	C-3	R3	H-1	R49	F-4	R96	B-3	R143	F-6	U19	H-6
C23	D-3	CR14	C-3	R4	H-1	R50	F-4	R97	B-3	R144	E-6	U20	H-
C24	E-4	CR15	C-3	R5	G-2	R51	F-4	R98	B-3	R145	E-6	U21	H-
C26	C-4	CR16	B-3	R6	G-2	R52	G-4	R99	C-4	R146	E-6	U22	G-6
C27	B-4	CR17	B-5	R7	G-2	R53	G-3	R100	B-4	R147	D-6	U23	F-4
C28	B-4	CR18	C-5	R8	G-3	R54	G-4	R101	C-4	R148	D-6	U24	F-5
C29	B-6	CR19	C-5	R9	G-2	R55	G-4	R102	C-4	R149	C-6	U25	J-4
C30	B-6	CR20	C-5	R10	H-2	R56	G-3	R103	D-4	R150	D-6	U26	J-4
C31	C-6	CR21	C-5	R11	H-2	R57	G-3	R104	E-3	R151	E-3	U27	E-5
C32	E-6	CR22	B-5	R12	H-2	R58	G-3	R105	D-4	R152	H-3	U28	D-4
C33	E-5	CR23	D-6	R13	G-3	R59	G-3	R106	E-4	R153	H-5	U29	E-3
C34	E-5	CR24	D-6	R14	G-3	R60	G-3	R107	E-4	R154	F-5	U30	G-2
C35	H-5	CR25	B-6	R15	G-3	R61	G-4	R108	E-4	R155	F-6	U31	E-6
C36	B-2	J1	C-6	R16	H-3	R62	G-5	R109	E-4	R156	D-1	U33	C-6
C37	C-2	J2	F-3	R17	G-3	R63	G-4	R110	C-6	R157	E-6	VR1	C-2
C38	C-6	J3	F-5	R18	G-3	R64	G-4	R111	E-4	R158	B-6	VR2	D-3
C39	F-2	J4	F-4	R19	F-3	R65	G-5	R113	D-4	R159	F-2	VR3	D-4
C40	B-6	J5	F-3	R20	G-3	R66	G-5	R114	D-4	R160	E-2	VR4	D-1
C41	D-1	J6	L-5	R21	F-3	R67	G-5	R115	C-4	R161	F-2	VR5	F-3
C42	J-2	J7	L-3	R22	F-3	R68	G-5	R116	B-4	R162	F-2	VR6	F-3
C43	F-2	J8	B-4	R23	F-3	R69	G-5	R117	C-4	R163	F-5	VR7	F-6
C44	J-6	J9	D-2	R24	E-2	R70	K-5	R118	B-5	R164	E-3	VR8	G-2
C45	J-2	J10	E-2	R25	F-3	R71	J-5	R119	B-5	R165	F-3	VR9	G-2
C46	J-5	J11	E-3	R26	F-3	R72	J-5	R120	B-5	R166	F-3	VR10	G-6
C47	J-5	J12	E-4	R27	J-3	R73	J-5	R121	B-5	R167	E-3	VR11	G-6
				R28	J-3	R74	J-5	R122	C-6				

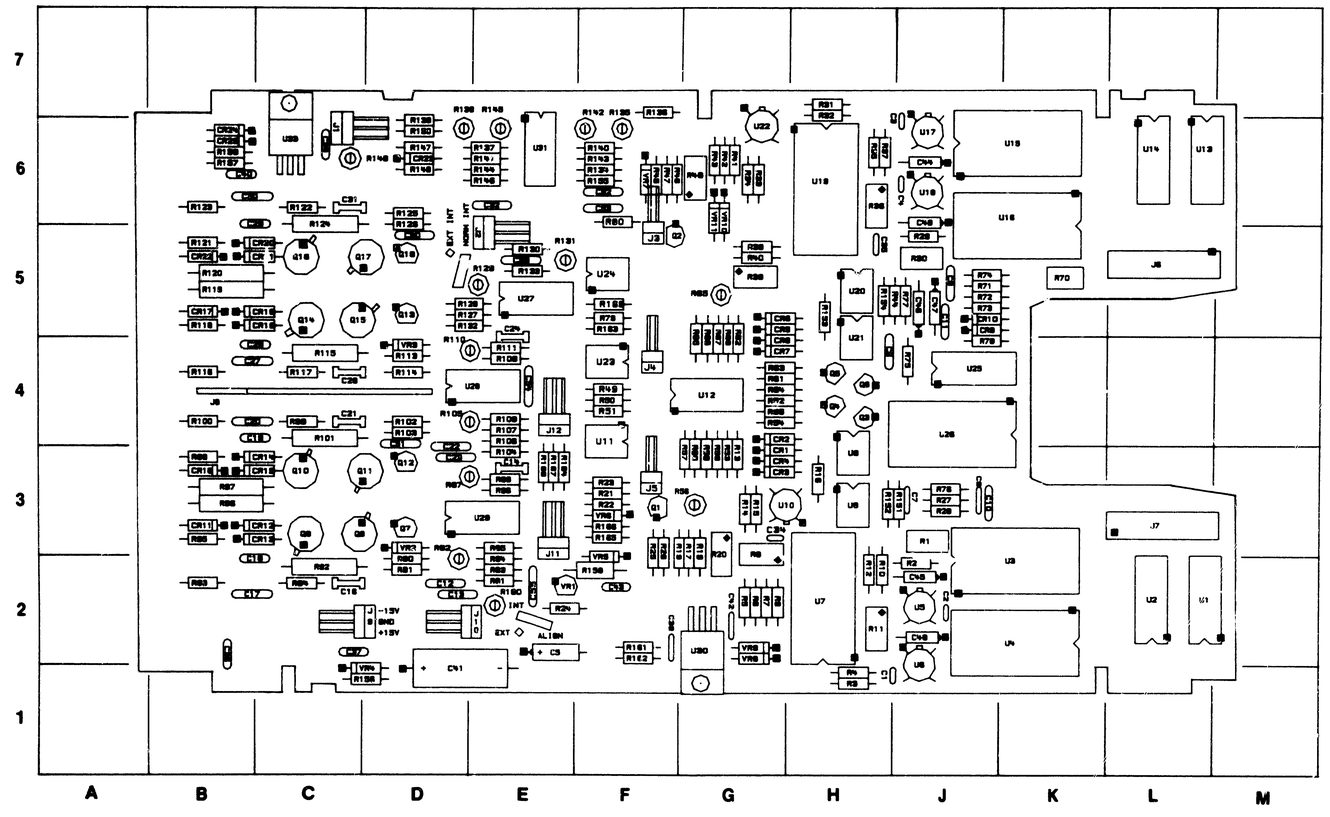


PARTS ON THIS SCHEMATIC		
P/O A1	A2	CHASSIS
C1-5,34-53 J4,5,8,9 P/O J6,P/O J7 Q1,2 R1-51,151-154, 156-159,161,162 U1-7,10-19,22,23, 30,33 VR1,4-11	P/O J2 P/O J3 A3 P/O J8	P/O W3 P/O W4

81345002/C10/81NOV84

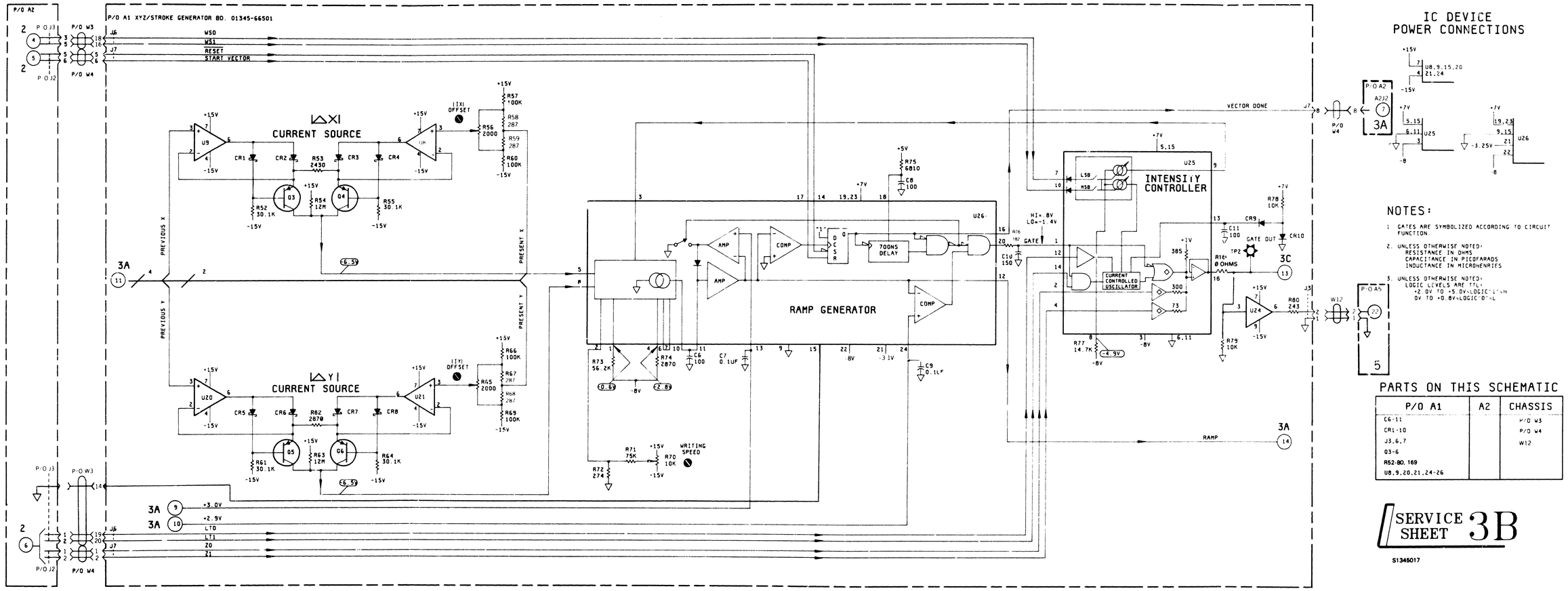
SERVICE SHEET 3A

Figure 8-10.
Service Sheet 3A, X-Y-Z Amp/Stroke Generator (A1)



REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC
C1	H-1	C48	J-2	Q1	F-3	R29	J-5	R75	J-4	R123	B-6	R168	E-3
C2	J-2	C49	J-6	Q2	F-5	R30	J-5	R76	J-3	R124	C-6	R169	F-5
C3	J-7	C50	D-5	Q3	H-4	R31	H-7	R77	J-5	R125	D-6	U1	L-2
C4	J-6	C51	D-4	Q4	H-4	R32	H-7	R78	J-4	R126	D-6	U2	L-2
C5	E-2	C52	F-6	Q5	H-4	R33	G-6	R79	F-5	R127	D-5	U3	K-2
C6	H-4	C53	F-6	Q6	H-4	R34	G-6	R80	F-6	R128	D-5	U4	K-2
C7	J-3	C54	E-4	Q7	D-3	R35	H-6	R81	E-2	R129	E-5	U5	J-2
C8	J-5	C55	E-2	Q8	C-3	R36	H-6	R82	D-2	R130	E-5	U6	J-2
C9	J-3	CR1	G-3	Q9	C-3	R37	H-6	R83	E-2	R131	E-5	U7	H-2
C10	J-3	CR2	G-4	Q10	C-3	R38	G-5	R84	E-2	R132	D-5	U8	H-3
C11	J-5	CR3	G-3	Q11	C-3	R39	G-5	R85	E-3	R133	E-5	U9	H-3
C12	D-2	CR4	G-3	Q12	D-3	R40	G-5	R86	E-3	R134	F-6	U10	G-3
C13	D-2	CR5	G-5	Q13	D-5	R41	G-6	R87	D-3	R135	F-6	U11	F-4
C14	E-3	CR6	G-5	Q14	C-5	R42	G-6	R88	E-3	R136	F-7	U12	G-4
C16	C-2	CR7	G-4	Q15	C-5	R43	G-6	R90	D-2	R137	E-6	U13	L-6
C17	B-2	CR8	G-4	Q16	C-5	R44	H-5	R91	D-2	R138	D-6	U14	L-6
C18	B-2	CR9	J-5	Q17	C-5	R45	F-6	R92	C-2	R139	D-7	U15	K-6
C19	B-4	CR10	J-5	Q18	D-5	R46	F-6	R93	B-2	R140	F-6	U16	K-6
C20	B-4	CR11	B-3	R1	J-3	R47	F-6	R94	C-2	R141	E-6	U17	J-6
C21	C-4	CR12	C-3	R2	J-2	R48	G-6	R95	B-3	R142	F-6	U18	J-6
C22	D-4	CR13	C-3	R3	H-1	R49	F-4	R96	B-3	R143	F-6	U19	H-6
C23	D-3	CR14	C-3	R4	H-1	R50	F-4	R97	B-3	R144	E-6	U20	H-5
C24	E-5	CR15	C-3	R5	G-2	R51	F-4	R98	B-3	R145	E-6	U21	H-5
C26	C-4	CR16	B-3	R6	G-2	R52	G-4	R99	C-4	R146	E-6	U22	G-6
C27	B-4	CR17	B-5	R7	G-2	R53	G-3	R100	B-4	R147	D-6	U23	F-4
C28	B-4	CR18	C-5	R8	G-3	R54	G-4	R101	C-4	R148	D-6	U24	F-5
C29	B-6	CR19	C-5	R9	G-2	R55	G-4	R102	D-4	R149	C-6	U25	J-4
C30	B-6	CR20	C-5	R10	H-2	R56	G-3	R103	D-4	R150	D-6	U26	J-4
C31	C-6	CR21	C-5	R11	H-2	R57	G-3	R104	E-3	R151	J-3	U27	E-5
C32	E-6	CR22	B-5	R12	H-2	R58	G-3	R105	D-4	R152	H-3	U28	D-4
C33	E-5	CR23	D-6	R13	G-3	R59	G-3	R106	E-4	R153	H-5	U29	E-3
C34	G-3	CR24	B-6	R14	G-3	R60	G-3	R107	E-4	R154	H-5	U30	G-2
C35	H-5	CR25	B-6	R15	G-3	R61	G-4	R108	E-4	R155	F-6	U31	E-6
C36	B-2	J1	C-6	R16	H-3	R62	G-5	R109	E-4	R156	D-1	U33	C-6
C37	C-2	J2	E-5	R17	G-3	R63	G-4	R110	D-4	R157	B-6	VR1	E-2
C38	C-6	J3	F-5	R18	G-3	R64	G-4	R111	E-4	R158	B-6	VR2	D-3
C39	F-2	J4	F-4	R19	F-3	R65	G-5	R113	D-4	R159	F-2	VR3	D-4
C40	B-6	J5	F-3	R20	G-3	R66	G-5	R114	D-4	R160	E-2	VR4	D-1
C41	D-1	J6	L-5	R21	F-3	R67	G-5	R115	C-4	R161	F-2	VR5	F-3
C42	G-2	J7	L-3	R22	F-3	R68	G-5	R116	B-4	R162	F-2	VR6	F-3
C43	F-2	J8	B-4	R23	F-3	R69	G-5	R117	C-4	R163	F-5	VR7	F-6
C44	J-6	J9	D-2	R24	E-2	R70	K-5	R118	B-5	R164	E-3	VR8	G-2
C45	J-2	J10	E-2	R25	F-3	R71	J-5	R119	B-5	R165	F-3	VR3	G-2
C46	J-5	J11	E-3	R26	F-3	R72	J-5	R120	B-5	R166	F-3	VR10	G-6
C47	J-5	J12	E-4	R27	J-3	R73	J-5	R121	B-5	R167	E-3	VR11	G-6
				R28	J-3	R74	J-5	R122	C-6				

P/O Service Sheet 3B, X-Y-Z Amp/Stroke Generator (A1)



IC DEVICE POWER CONNECTIONS

NOTES:

1. GATES ARE SYMBOLIZED ACCORDING TO CIRCUIT FUNCTION.
2. UNLESS OTHERWISE NOTED:
 RESISTANCE IN OHMS
 CAPACITANCE IN PICOFARADS
 INDUCTANCE IN MICROHENRIES
3. UNLESS OTHERWISE NOTED:
 LOGIC LEVELS ARE TTL:
 +2.0V TO +5.0V=LOGIC "1"=H
 0V TO +0.8V=LOGIC "0"=L

PARTS ON THIS SCHEMATIC

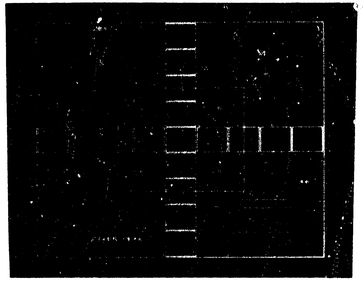
P/O A1	A2	CHASSIS
C6-11		P/O W3
CR1-10		P/O W4
J3,6,7		W12
Q3-6		
R52-80,169		
U8,9,20,21,24-26		

SERVICE SHEET 3B

S1345017

Figure 8-11.
Service Sheet 3B, X-Y-Z Amp/Stroke Generator (A1)

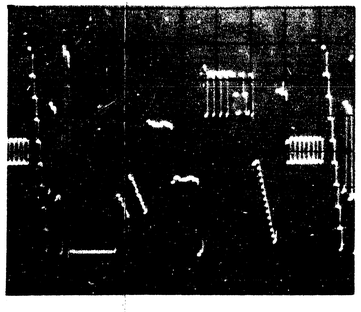
WAVEFORM MEASUREMENT CONDITION



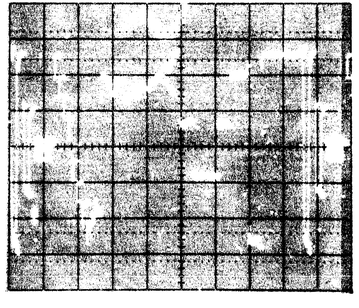
OBTAIN PRIMARY TEST PATTERN AS SHOWN ABOVE

NOTE:

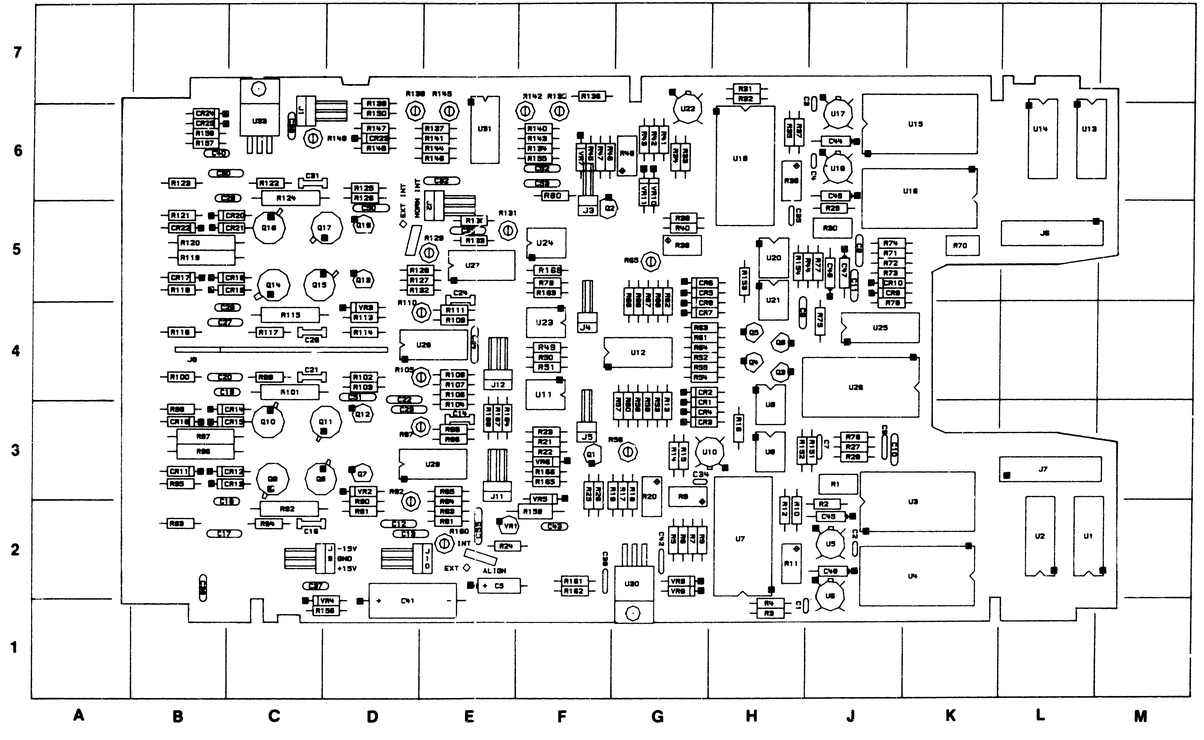
WAVEFORM MEASURMENTS TAKEN WITHOUT MEMORY CIRCUIT INSTALLED.



X OUTPUT AT A1Q8 COLLECTOR
(TO HORIZONTAL DEFLECTION PLATES)
10 V/DIV, 2ms/DIV

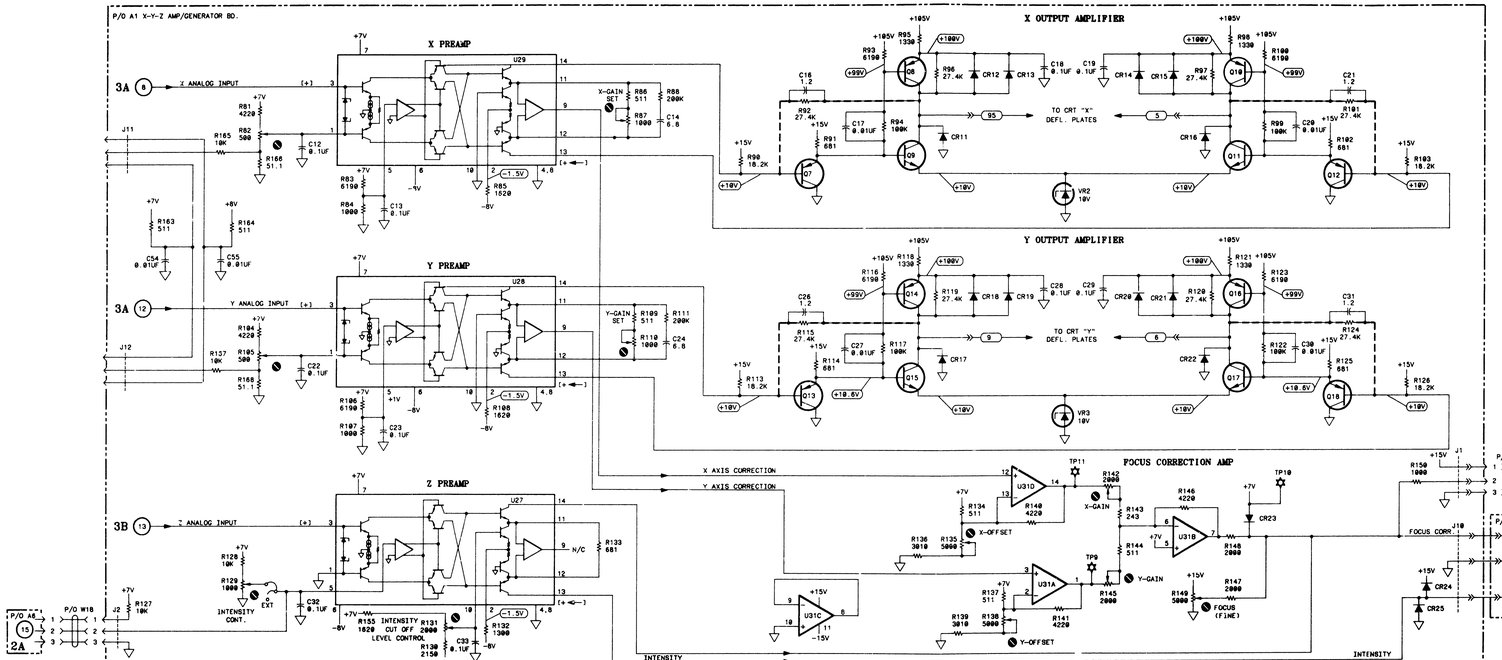


Y OUTPUT AT A1Q14 COLLECTOR
(TO VERTICAL DEFLECTION PLATES)
10 V/DIV, 2ms/DIV

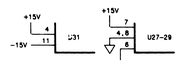


P/O Service Sheet 3C, X-Y-Z Amp/Stroke Generator (A1)

REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC
C1	H-1	C48	J-2	Q1	F-3	R29	J-5	R75	J-4	R123	B-6	R168	E-3
C2	J-2	C49	J-5	Q2	F-5	R30	J-5	R76	J-3	R124	C-6	R169	F-5
C3	J-7	C50	D-5	Q3	H-4	R31	H-7	R77	J-5	R125	D-6	U1	L-2
C4	J-6	C51	D-4	Q4	H-4	R32	H-7	R78	J-4	R126	D-6	U2	L-2
C5	E-2	C52	F-6	Q5	H-4	R33	G-6	R79	F-5	R127	D-5	U3	K-2
C6	H-4	C53	F-6	Q6	H-4	R34	G-6	R80	F-6	R128	D-5	U4	K-2
C7	J-3	C54	E-4	Q7	D-3	R35	H-6	R81	E-2	R129	E-5	U5	J-2
C8	J-5	C55	E-2	Q8	C-3	R36	H-6	R82	D-2	R130	E-5	U6	J-2
C9	J-3	CR1	G-3	Q9	C-3	R37	H-6	R83	E-2	R131	E-5	U7	H-2
C10	J-3	CR2	G-4	Q10	C-3	R38	G-5	R84	E-2	R132	D-5	U8	H-3
C11	J-5	CR3	G-3	Q11	C-3	R39	G-5	R85	E-3	R133	E-5	U9	H-3
C12	D-2	CR4	G-3	Q12	D-3	R40	G-5	R86	E-3	R134	F-6	U10	G-3
C13	D-2	CR5	G-5	Q13	D-5	R41	G-6	R87	D-3	R135	F-6	U11	F-4
C14	E-3	CR6	G-5	Q14	C-5	R42	G-6	R88	E-3	R136	F-7	U12	G-4
C16	C-2	CR7	G-4	Q15	C-5	R43	G-6	R90	D-2	R137	E-6	U13	L-6
C17	B-2	CR8	G-4	Q16	C-5	R44	H-5	R91	D-2	R138	D-6	U14	L-6
C18	B-2	CR9	J-5	Q17	C-5	R45	F-6	R92	C-2	R139	D-7	U15	K-6
C19	B-4	CR10	J-5	Q18	D-5	R46	F-6	R93	B-2	R140	F-6	U16	K-6
C20	B-4	CR11	B-3	R1	J-3	R47	F-6	R94	C-2	R141	E-6	U17	J-6
C21	C-4	CR12	C-3	R2	J-2	R48	G-6	R95	B-3	R142	F-6	U18	J-6
C22	D-4	CR13	C-3	R3	H-1	R49	F-4	R96	B-3	R143	F-6	U19	H-6
C23	D-3	CR14	C-3	R4	H-1	R50	F-4	R97	B-3	R144	E-6	U20	H-5
C24	E-5	CR15	C-3	R5	G-2	R51	F-4	R98	B-3	R145	F-6	U21	H-5
C26	C-4	CR16	B-3	R6	G-2	R52	G-4	R99	C-4	R146	E-6	U22	G-6
C27	B-4	CR17	B-3	R7	G-2	R53	G-3	R100	B-4	R147	D-6	U23	F-4
C28	B-4	CR18	C-5	R8	G-3	H54	G-4	R101	C-4	R148	D-6	U24	F-5
C29	B-6	CR19	C-5	R9	G-2	R55	G-4	R102	D-4	R149	C-6	U25	J-4
C30	B-6	CR20	C-5	R10	H-2	R56	G-3	R103	D-4	R150	D-6	U26	J-4
C31	C-6	CR21	C-5	R11	'-2	R57	G-3	R104	E-3	R151	J-3	U27	E-5
C32	E-6	CR22	B-5	R12	H-2	R58	G-3	R105	D-4	R152	H-3	U28	D-4
C33	E-5	CR23	D-6	R13	G-3	R59	G-3	R106	E-4	R153	H-5	U29	E-3
C34	G-3	CR24	B-6	R14	G-3	R60	G-3	R107	E-4	R154	H-5	U30	G-2
C35	H-5	CR25	B-6	R15	G-3	R61	G-4	R108	E-4	R155	F-6	U31	E-6
C36	B-2	J1	C-6	R16	H-3	R62	G-5	R109	E-4	R156	D-1	U33	C-6
C37	C-2	J2	E-5	R17	G-3	R63	G-4	R110	D-4	R157	B-6	VR1	E-2
C38	C-6	J3	F-5	R18	G-3	R64	G-4	R111	E-4	R158	B-6	VR2	D-3
C39	F-2	J4	F-4	R19	F-3	R65	G-5	R113	D-4	R159	F-2	VR3	D-4
C40	B-6	J5	F-3	R20	G-3	R66	G-5	R114	D-4	R160	E-2	VR4	D-1
C41	D-1	J6	L-5	R21	F-3	R67	G-5	R115	C-4	R161	F-2	VR5	F-3
C42	G-2	J7	L-3	R22	F-3	R68	G-5	R116	B-4	R162	F-2	VR6	F-3
C43	F-2	J8	B-4	R23	F-3	R69	G-5	R117	C-4	R163	F-5	VR7	F-6
C44	J-5	J9	D-2	R24	E-2	R70	K-5	R118	B-5	R164	E-3	VR8	G-2
C45	J-2	J10	E-2	R25	F-3	R71	J-5	R119	B-5	R165	F-3	VR9	G-2
C46	J-5	J11	E-3	R26	F-3	R72	J-5	R120	B-5	R166	F-3	VR10	G-6
C47	J-5	J12	E-4	R27	J-3	R73	J-5	R121	B-5	R167	E-3	VR11	G-6
				R28	J-3	R74	J-5	R122	C-6				



IC DEVICE POWER CONNECTIONS



NOTES:

1. GATES ARE SYMBOLIZED ACCORDING TO CIRCUIT FUNCTION.
2. UNLESS OTHERWISE NOTED:
 RESISTANCE IN OHMS
 CAPACITANCE IN MICROFARADS
 INDUCTANCE IN MICROHENRIES
3. UNLESS OTHERWISE NOTED:
 LOGIC LEVELS ARE TTL:
 +2.0V TO +5.0V=LOGIC"1"=H
 0V TO +0.8V=LOGIC"0"=L

PARTS ON THIS SCHEMATIC

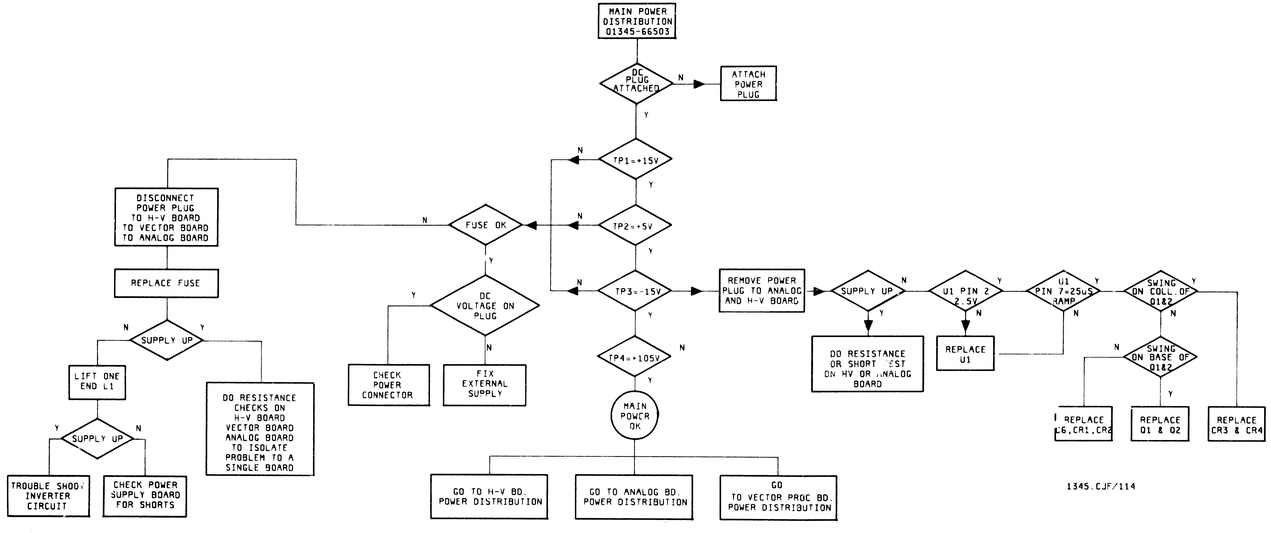
P/O A1

C12-14,16-24,26-33,54,55
CR11-25
J1,2,10-12
Q7-18
R91-98,99-111,113-150,155,163-168
U2-29,31
VR2-3
W18

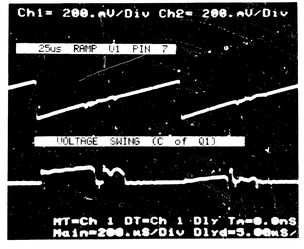
S1345054/98998/19MAR85

3C

Figure 8-11.
Service Sheet 3C, X-Y-Z Amp/Stroke Generator (A1)



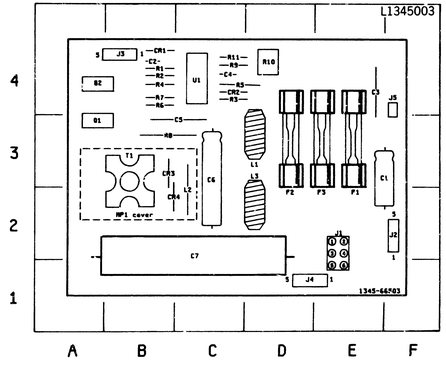
1345.CJF/114



TOP OSCILLATOR SIGNAL AT A3U1 PIN 7
BOTTOM COLLECTOR OF A3Q1

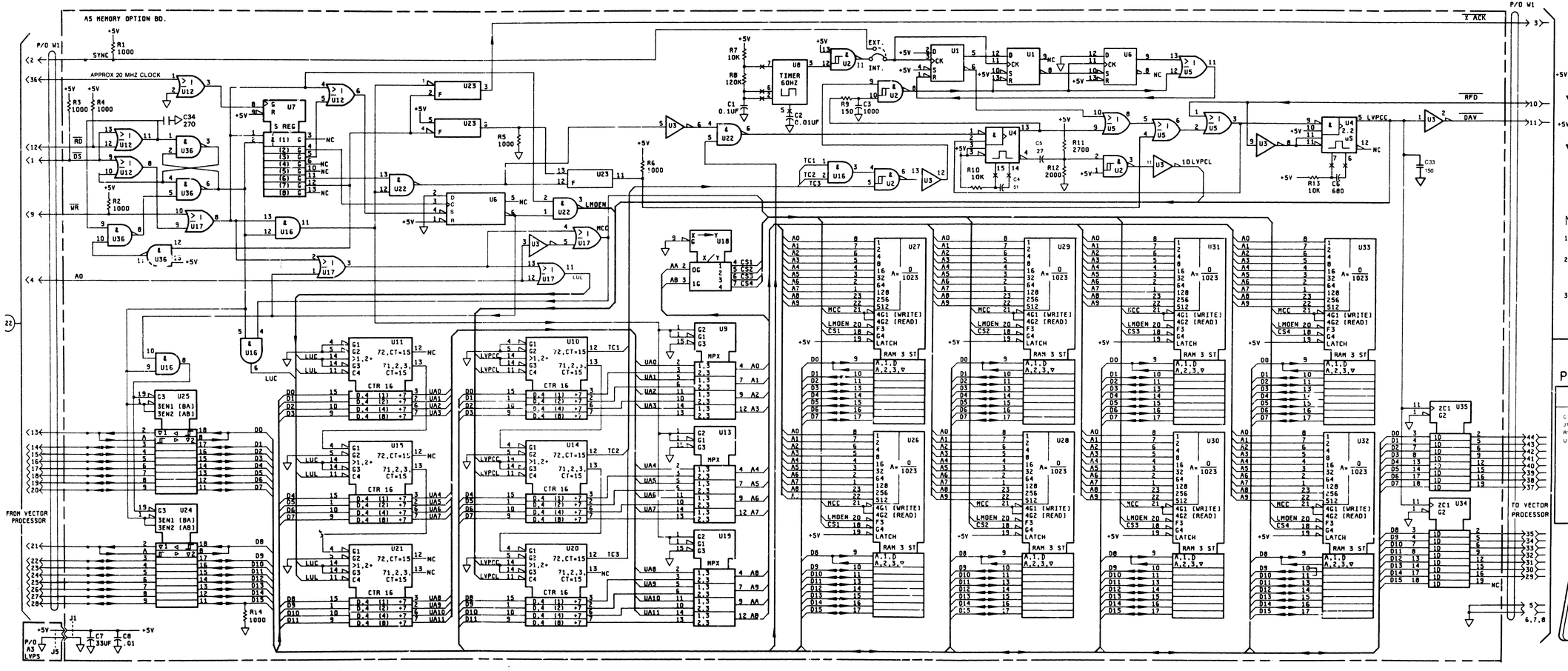
NOTE:

WAVEFORM MEASUREMENTS TAKEN WITHOUT MEMORY CIRCUIT INSTALLED

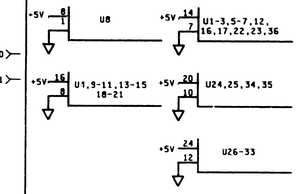


REF. DESIG	GRID LOC.	REF. DESIG	GRID LOC
C1	E 3	L1	D 3
C2	B 4	L2	C 3
C3	E 4	L3	D 3
C4	C 4	MP1	B 2
C5	C 3	Q1	A 3
C6	C 3	Q2	A 2
C7	C 2	R1	B 4
CR1	B 4	R2	B 4
CR2	C 4	R3	C 4
CR3	B 3	R4	B 4
CR4	B 2	R5	C 4
F1	E 2	R6	B 4
F2	D 2	R7	B 4
F3	E 2	R8	B 3
J1	E 2	R9	C 4
J2	E 2	R10	D 4
J3	B 4	R11	C 4
J4	D 1	T1	B 3
J5	F 4	U1	C 4

P/O Service Sheet 4, Low Voltage Power Supply (A3)



IC DEVICE POWER CONNECTIONS



NOTES:

1. GATES ARE SYMBOLIZED ACCORDING TO CIRCUIT FUNCTION.
2. UNLESS OTHERWISE NOTED:
 RESISTANCE IN OHMS
 CAPACITANCE IN PICOFARADS
 INDUCTANCE IN MICROHENRIES
3. UNLESS OTHERWISE NOTED:
 LOGIC LEVELS ARE TTL:
 +2.0V TO +5.0V=LOGIC "1"=H
 0V TO +0.8V=LOGIC "0"=L

(22) 2

PARTS ON THIS SCHEMATIC

A5	CHASSIS
C1-33 J1 R1-14 U1-36	W1

SERVICE SHEET 6

1345/105/CLG/04-11-81

Figure 7-6.
Replacement for Service Sheet 6, Schematic Diagram Memory (Option 704) Board. Part No. 01345-66511.

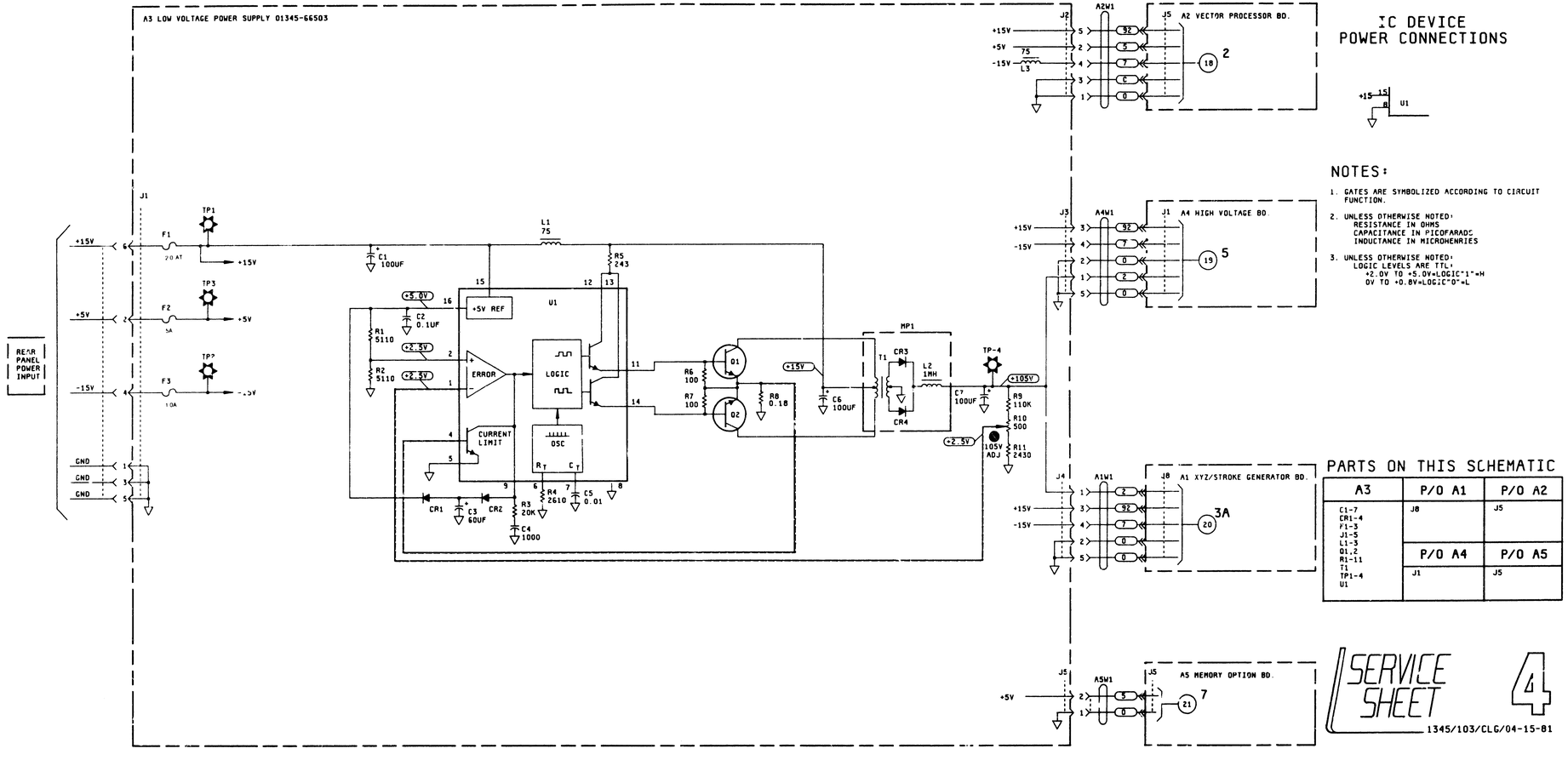
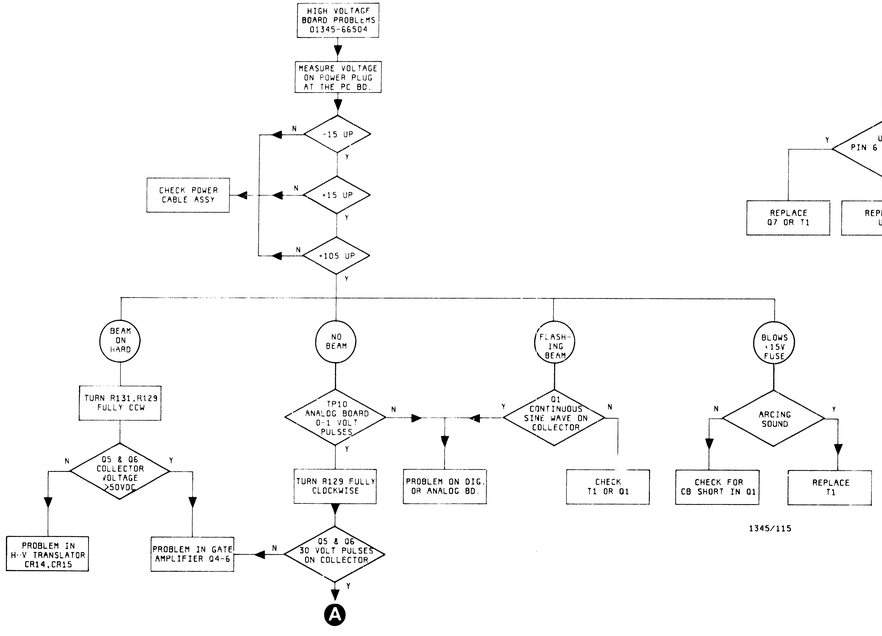
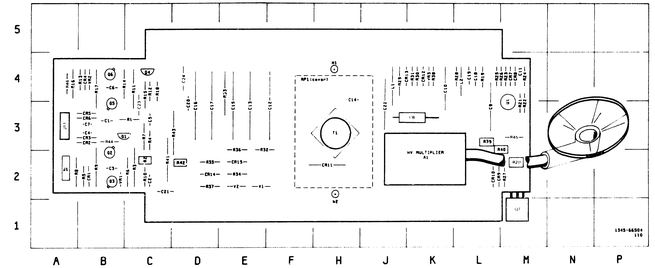


Figure 8-13.
Service Sheet 4, Low Voltage Power Supply (A3)

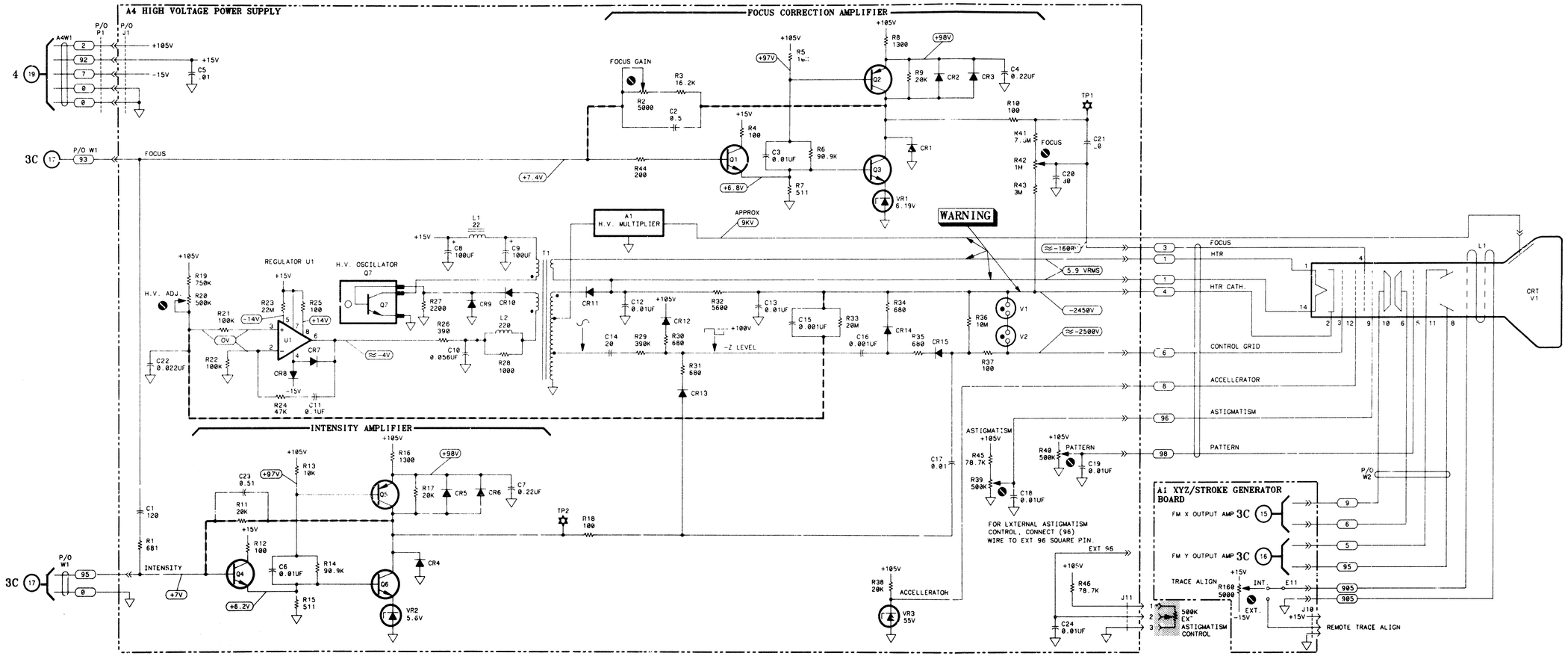


1345/115



REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC
A1	K 2	C21	C 2	H2	H 1	R13	B 4	R35	D 2		
C1	B 3	C22	J 3	L1	J 4	R14	B 4	R36	E 3		
C2	C 2	C23	C 3	L2	I 4	R15	C 4	R37	D 2		
C3	B 2	C24	D 4	MP1	I 4	R16	A 4	R38	K 4		
C4	B 3	CR1	B 2	Q1	B 3	R17	B 4	R39	L 3		
C5	C 3	CR2	B 3	Q2	B 2	R18	C 4	R40	M 3		
C6	B 4	CR3	B 3	Q3	B 2	R19	L 4	R41	C 2		
C7	B 3	CR4	B 4	Q4	C 4	R20	M 2	R42	D 2		
C8	K 3	CR5	B 3	Q5	B 3	R21	M 3	R43	D 3		
C9	L 3	CR6	B 3	Q6	B 4	R22	M 3	R44	B 3		
C10	K 4	CR7	M 4	Q7	M 1	R23	M 4	R45	M 3		
C11	M 4	CR8	M 4	R1	C 3	R24	M 4	R46	A 4		
C12	F 3	CR9	L 2	R2	C 2	R25	L 4	T1	H 3		
C13	E 4	CR10	L 2	R3	C 2	R26	M 4	U1	M 3		
C14	H 4	CR11	H 2	R4	C 3	R27	M 2	V1	E 2		
C15	E 4	CR12	K 4	R5	B 2	R28	L 4	V2	E 2		
C16	D 3	CR13	J 4	R6	C 2	R29	J 4	VR1	H 2		
C17	D 3	CR14	D 2	R7	C 3	R30	K 4	VR2	R 4		
C18	L 4	CR15	L 2	R8	A 2	R31	K 4	VR3	K 4		
C19	L 4	J1	A 2	R9	B 2	R32	E 3				
C20	D 3	J11	A 3	R10	C 2	R33	E 4				
		H1	H 4	R11	C 4	R34	E 2				
				R12	C 4						

P/O Service Sheet 5, High Voltage Power Supply (A4)



NOTES:

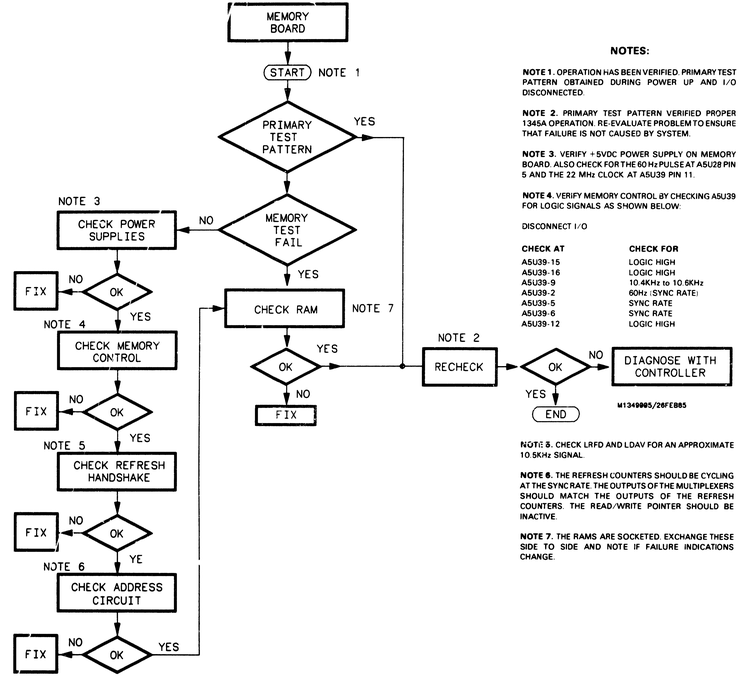
1. GATES ARE SYMBOLIZED ACCORDING TO CIRCUIT FUNCTION.
2. UNLESS OTHERWISE NOTED:
 RESISTANCE IN OHMS
 CAPACITANCE IN PICOFARADS
 INDUCTANCE IN MICROHENRIES
3. UNLESS OTHERWISE NOTED:
 LOGIC LEVELS ARE TTL:
 +2.0V TO +5.0V=LOGIC "1" =H
 0V TO +0.8V=LOGIC "0" =L

PARTS ON THIS SCHEMATIC		
A5	P/O A1	CHASSIS
C1-24 CR1-15 L1,2 Q1-7 R1-46 T1 U1 V1,2 VR1-3	R160 J10	P/O W1 P/O W2 V1 L1

S1345051/2-19-85

5

Figure 8-14.
Service Sheet 5, High Voltage Power Supply (A4)



NOTES:

NOTE 1. OPERATION HAS BEEN VERIFIED. PRIMARY TEST PATTERN OBTAINED DURING POWER UP AND I/O DISCONNECTED.

NOTE 2. PRIMARY TEST PATTERN VERIFIED. PROPER 1345A OPERATION. RE-EVALUATE PROBLEM TO ENSURE THAT FAILURE IS NOT CAUSED BY SYSTEM.

NOTE 3. VERIFY +5VDC POWER SUPPLY ON MEMORY BOARD. ALSO CHECK FOR THE 60 Hz PULSE AT A5U28 PIN 5 AND THE 22 MHz CLOCK AT A5U39 PIN 11.

NOTE 4. VERIFY MEMORY CONTROL BY CHECKING A5U39 FOR LOGIC SIGNALS AS SHOWN BELOW:

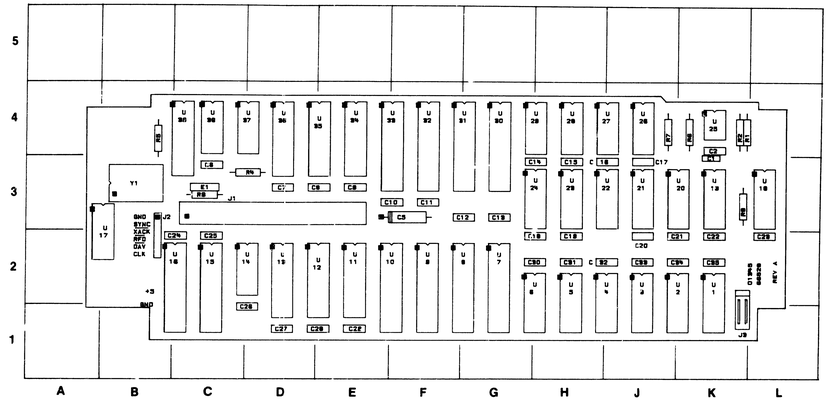
DISCONNECT I/O

CHECK AT	CHECK FOR
A5U39-15	LOGIC HIGH
A5U39-16	LOGIC HIGH
A5U39-9	10.4KHz to 10.6KHz
A5U39-2	60Hz (SYNC RATE)
A5U39-5	SYNC RATE
A5U39-6	SYNC RATE
A5U39-12	LOGIC HIGH

NOTE 5. CHECK LRFD AND LDAV FOR AN APPROXIMATE 10.5KHz SIGNAL.

NOTE 6. THE REFRESH COUNTERS SHOULD BE CYCLING AT THE SYNC RATE. THE OUTPUTS OF THE MULTIPLEXERS SHOULD MATCH THE OUTPUTS OF THE REFRESH COUNTERS. THE READ/WRITE POINTER SHOULD BE INACTIVE.

NOTE 7. THE RAMS ARE SOCKETED. EXCHANGE THESE SIDE TO SIDE AND NOTE IF FAILURE INDICATIONS CHANGE.



REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC
C1	K-3	C25	C-2	R8	K-3	U20	J-3
C4	K-4	C26	C-1	R9	C-3	U21	J-3
C5	F-3	C27	D-1	U1	K-2	U22	H-3
C6	C-3	C28	D-1	U2	J-2	U23	H-3
C7	D-3	C29	E-1	U3	J-2	U24	G-3
C8	D-3	C30	G-2	U4	H-2	U25	K-4
C9	E-3	C31	H-2	U5	H-2	U26	J-4
C10	E-3	C32	H-2	U6	G-2	U27	H-4
C11	F-3	C33	J-2	U7	G-2	U28	H-4
C12	F-3	C34	J-?	U8	F-2	U29	G-4
C13	G-3	C35	K-2	U9	F-2	U30	G-4
C14	G-3	E1	C-3	U10	E-2	U31	F-4
C15	H-3	J1	C-3	U11	E-2	U32	F-4
C16	H-3	J2	B-3	U12	D-2	U33	E-4
C17	J-3	J3	K-1	U13	D-2	U34	E-4
C18	G-2	R1	K-4	U14	C-2	U35	D-4
C19	H-2	R2	K-4	U15	C-2	U36	D-4
C20	J-2	R4	C-3	U16	B-2	U37	C-4
C21	J-2	R5	B-4	U17	A-2	U38	C-4
C22	K-2	R6	K-4	U18	L-3	U39	C-4
C23	L-2	R7	J-4	U19	K-3	Y1	B-3
C24	B-2						

P/O Service Sheet 6, Memory (Option 704, A5)

Table 7-2. Replacement for A-2 Parts List

Reference Designator	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A2	01345-66519	8	1	BOARD-VECT PROD	28480	01345-66519
A2C1	0160-2264	2	3	CAPACITOR-FXD 20PF ±5% 500V DC CER 0±30	28480	0160-2264
A2C2	0160-2264	2		CAPACITOR-FXD 20PF ±5% 500VDC CER 0±30	28480	0160-2264
A2C3	0180-0374	3		CAPACITOR-FXD 10UF±10% 20VDC TA	56289	150D106X902082
A2C4	0160-3443	1		CAPACITOR-FXD 1UF +80-20% 50VDC CER	28480	0160-3443
A2C5	0160-3443	1		CAPACITOR-FXD 1UF +80-20% 50VDC CER	28480	0160-3443
A2C6	0160-3451	1	12	CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-3451
A2C7	0160-3443	1		CAPACITOR-FXD 1UF +80-20% 50VDC CER	28480	0160-3443
A2C8	0160-3451	1		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-3451
A2C9	0160-3451	1		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-3451
A2C10	0160-3451	1		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-3451
A2C11	0160-3451	1		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-3451
A2C12	0160-3451	1		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-3451
A2C13	0160-3451	1		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-3451
A2C14	0160-3451	1		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-3451
A2C15	0160-3451	1		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-3451
A2C16	0160-3451	1		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-3451
A2C17	0160-3451	1		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-3451
A2C18	0160-3451	1		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-3451
A2CR1	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A2CR2	1901-1065	2	1	DIODE-PWR RECT 400V 1A	28480	1901-1065
A2H1	2190-0005	0	2	WASHER-LK EXT T NO 4 .116-IN-ID	28480	2190-0005
A2H2	0515-0403	0	2	SCREW-MACH 2.5 × .48 × 8MM	00000	ORDER BY DESCRIPTION
A2H3	0535-0008	3	2	NUT-HEX-DBL-CHAM M 2.5 × 0.45 × 2MM	28480	0535-0008
A2J1	1251-6905	0	1	CONNECTOR 44-PIN M POST TYPE	28480	1251-6905
A2J2	1251-6823	1		CONNECTOR 20-PIN M POST TYPE	28480	1251-6823
A2J3	1251-6823	1		CONNECTOR 20-PIN M POST TYPE	28480	1251-6823
A2J4	1251-7229	3		CONNECTOR 16-PIN M RIGHT ANGLE	28480	1251-7229
A2J5	1251-5863	7		CONNECTOR 5-PIN M METRIC POST TYPE	28480	1251-5863
A2L1	9100-1629	4	1	INDUCTOR RF-CH-MLD 47UH 5% .166DX.385LG	28480	9100-1629
A2Q1	1854-0300	5	1	TRANSISTOR NPN SI PD=.21W FT=10MHZ	28480	1854-0300
A2Q2	1854-0215	1	3	TRANSISTOR NPN SI PD=350MW FT=300MHZ	04713	2N3904
A2R1	0683-1035	1	7	RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A2R2	0683-1025	9	16	RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A2R3	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A2R4	0757-0280	3		RESISTOR 1K 1% .125W F TC=0±100	24546	C4-1/8-T0-1001-F
A2R5	0698-3394	0	1	RESISTOR 31.6 1% .5W F TC=0+100	28480	0698-3394
A2R6	0757-0159	5	1	RESISTOR 1K 1% .5W F TC=0+100	28480	0757-0159
A2R7	0698-3154	0		RESISTOR 4.22K 1% .125W F TC=0±100	24546	C4-1/8-T0-4221 F
A2R8	0761-0035	5	1	RESISTOR 150 5% 1W MO TC=0+200	28480	0761-0035
A2R9	0757-0416	7		RESISTOR 511 1% .125W F TC=0+100	24546	C4-1/8-T0-511R-F
A2R10	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A2R11	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A2R12	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A2R13	0683-0275	9		RESISTOR 2.7 5% .25W FC TC=-400/+500	28480	0683-0275
A2R14	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A2R15	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1025
A2R16	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A2R17	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A2R18	0757-0449	6	3	RESISTOR 20K 1% .125W F TC=0±100	24546	C4-1/8-T0-2002-F
A2R19	0757-0416	7		RESISTOR 511 1% .125W F TC=0+100	24546	C4-1/8-T0-511R-F
A2R20	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A2R21	0757-0273	4		RESISTOR 3.01K 1% .125W F TC=0+100	24546	C4-1/8-T0-3011 F
A2R22	0683-1025	9	1	RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A2R23	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A2R24	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A2R25	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+600	01121	CB1035
A2R26	0757-0273	4	1	RESISTOR 3.01K 1% .125W F TC=0±100	24546	C4-1/8-T0-3011 F
A2R27	0757-0280	3	1	RESISTOR 1K 1% .125W F TC=0±100	24546	C4-1/8-T0-1001 F
A2U1	01347-80010	6	1	IC-MCU 8048	28480	01347-80010
A2U2	1820-1297	0	1	IC GATE TTL LS EXCL-NOR QUAD 2-INP	01295	SN74LS266N
A2U3	1810-0307	0	2	NETWORK-CNDCT MODULE DIP; 16 PINS; 0.100	28480	1810-0307
A2U4	1810-0307	0		NETWORK-CNDCT MODULE DIP; 16 PINS; 0.100	28480	1810-0307
A2U5	1816-1500	9	1	IC TTL S 4096 (4K) PROM85-NS 3-S	01295	TBP18S42N
A2U6	1820-2024	3	4	IC DRVR TTL LS LINE DRVR OCTL	01295	SN74LS244N
A2U7	1820-1198	0		IC GATE TTL LS NAND WUAD 2-INP	28480	1820-1198
A2U8	1820-2024	3		IC DRVR TTL LS LINE DRVR OCTL	01295	SN74LS244N
A2U9	1820-1432	5	4	IC CNTR TTL LS BIN SYNCHRO POS-EDGE-TRIG	01295	SN74LS163AN
A2U10	1820-1432	5		IC CNTR TTL LS BIN SYNCHRO POS-EDGE-TRIG	01295	SN74LS163AN
A2U11	1820-1432	5		IC CNTR TTL LS BIN SYNCHRO POS-EDGE-TRIG	01295	SN74LS163AN
A2U12	01347-80012	8	1	IC NMOS 16384 (16K) ROM300-NS 3-S	28480	01347-80012

See introduction to this section for ordering information

Table 7-2. Replacement for A-2 Parts List (Cont'd)

Reference Designator	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A2U13	1820-2024	3		IC DRVR TTL LS LINE DRVR OCTL	01295	SN74LS244N
A2U14	1813-0149	4	1	IC OSC HYBRID	34344	K1148A-19.6608MHZ
A2U15	1820-1322	2	1	IC GATE TTL S NOR QUAD 2-INP	01295	SN74S02N
A2U16	1820-2617	5	1	IC SCNR HTL	28480	1SB5-0025
A2U17	1820-2024	3		IC DRVR TTL LS LINE DRVR OCTL	01295	SN74LS244N
A2U18	1820-1997	7	2	IC FF TTL LS D TYPE POS-EDGE-TRIG PRL-IN	01295	SN74LS374N
A2U19	1820-1997	7		IC FF TTL LS D-TYPE POS-EDGE-TRIG PRL-IN	01295	SN74LS374N
A2U20	1820-1444	9	1	IC MUXR/DATA-SEL TTL LS 2-TO-1-LINE QUAD	01295	SN74LS298N
A2U21	1820-1422	3	1	IC MV TTL LS MONOSTBL RETRIG	01295	SN74LS122N
A2U22	1820-1196	8		IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS174N
A2U23	1820-1196	8		IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS174N
A2U24	1820-1196	8		IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS174N
A2U25	1820-1196	8		IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS174N
A2U26	1820-1432	5		IC CNTR TTL LS BIN SYNCHRO POS-EDGE-TRIG	01295	SN74LS163AN
A2U27	1820-1217	4	1	IC MUXR/DATA-SEL TTL LS 8-TO-1 LINE	01295	SN74LS151N
A2VR1	1902-3126	2	1	DIODE-ZNR 7.15V 2% DO-35 PD=.4W	28480	1902-3126
A2XU1	1200-0654	7	2	SOCKET-IC 40-CONT DIP DIP-SLDR	28480	1200-0654
A2XU3	1200-0607	0	3	SOCKET-IC 16-CONT DIP DIP-SLDR	28480	1200-0607
A2XU4	1200-0607	0		SOCKET-IC 16-CONT DIP DIP-SLDR	28480	1200-0607
A2XU5	1200-0639	8	1	SOCKET-IC 20-CONT DIP DIP-SLDR	28480	1200-0639
A2XU12	1200-0541	1	1	SOCKET-IC 24-CONT DIP DIP-SLDR	28480	1200-0541
A2XU16	1200-0654	7		SOCKET-IC 40-CONT DIP DIP-SLDR	28480	1200-0654

See introduction to this section for ordering information

Table 7-3. Replacement for A-4 Parts List

Reference Designator	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A4R17	0757-0190	4		RESISTOR 20K 1% .5W F TC=0±100	28480	0757-0190
A4R18	0684-1011	5		RESISTOR 100 10% .25W FC TC=-400/+500	01121	CB1011
A4R19	0757-0486	1	1	RESISTOR 750K 1% .125W F TC=0±100	28480	0757-0486
A4R20	2100-3357	2	3	RESISTOR-TRMR 500K 10% C SIDE-ADJ 1-TRN	28480	2100-3357
A4R21	0757-0465	6		RESISTOR 100K 1% .125W F TC=0±100	24546	C4-1/8-TO-1003-F
A4R22	0757-0465	6		RESISTOR 100K 1% .125W F TC=0±100	24546	C4-1/8-TO-1003-F
A4R23	0683-2265	1	1	RESISTOR 22M 5% .25W FC TC=-900/+1200	01121	CB2265
A4R24	0684-4731	2	1	RESISTOR 47K 10% .25W FC TC=-400/+800	01121	CB4731
A4R25	0684-1011	5		RESISTOR 100 10% .25W FC TC=-400/+500	01121	CB1011
A4R26	0683-3915	0	1	RESISTOR 390 5% .25W FC TC=-400/+600	01121	CB3915
A4R27	0684-2221	1	1	RESISTOR 2.2K 10% .25W FC TC=-400/+700	01121	CB2221
A4R28	0684-1021	7	1	RESISTOR 1K 10% .25W FC TC=-400/+800	01121	CB1021
A4R29	0687-3941	0	1	RESISTOR 390K 10% .5W CC TC=0+882	01121	EB3941
A4R30	0684-6811	3		RESISTOR 680 10% .25W FC TC=-400/+600	01121	CB6811
A4R31	0684-6811	3		RESISTOR 680 10% .25W FC TC=-400/+800	01121	CB6811
A4R32	0684-5621	1	1	RESISTOR 5.6K 10% .25W FC TC=-400/+700	01121	CB5621
A4R33	0699-0167	1	1	RESISTOR 20M 5% 1W C TC=0±250	28480	0699-0167
A4R34	0684-6811	3		RESISTOR 680 10% .25W FC TC=-400/+600	01121	CB6811
A4R35	0684-6811	3		RESISTOR 680 10% .25W FC TC=-400/+600	01121	CB6811
A4R36	0684-1061	5	1	RESISTOR 10M 10% .25W FC TC=-900/+1100	01121	CB1061
A4R37	0684-1011	5		RESISTOR 100 10% .25W FC TC=-400/+500	01121	CB1011
A4R38	0757-0449	6		RESISTOR 20K 1% .125W F TC=0±100	24546	C4-1/8-TO-2002-F
A4R39	2100-3357	2		RESISTOR-TRMR 500K 10% C SIDE-ADJ 1-TRN	28480	2100-3357
A4R40	2100-3357	2		RESISTOR-TRMR 500K 10% C SIDE-ADJ 1-TRN	28480	2100-3357
A4R41	0699-0974	8	1	RESISTOR 7.5M 5% 1W C TC=0±250	28480	0699-0974
A4R42	2100-3358	3	1	RESISTOR-TRMR 1M 20% C SIDE-ADJ 1-TRN	28480	2100-3358
A4R43	0699-0172	8	1	RESISTOR 3M 5% 1W C TC=0±250	28480	0699-0172
A4R44	0757-0407	6	1	RESISTOR 200 1% .125W F TC=0±100	24546	C4-1/8-TO-201-F
A4R45	0698-4508	0	2	RESISTOR 78.7K 1% .125W F TC=0±100	28480	0698-4508
A4R46	0698-4508	0		RESISTOR 78.7K 1% .125W F TC=0±100	28480	0698-4508
A4T1	01345-61101	6	1	HV TRANSFORMER	28480	01345-61101
A4U1	1826-0167	3	1	IC OP AMP PRGMBL TO-99 PKG	01928	CA3094AT
A4V1	2140-0018	0	2	LAMP-GLOW A9A-CT 90VDC 700UA T-2-BULB	0046G	A9A-CT
A4V2	2140-0018	0		LAMP-GLOW A9A-CT 90VDC 700UA T-2-BULB	0046G	A9A-CT
A4VR1	1902-0049	2	2	DIODE-ZNR 6.19V 5% DO-35 PD=.4W	28480	1902-0049
A4VR2	1902-3104	6		DIODE-ZNR 5.62V 5% DO-35 PD=.4W	28480	1902-3104
A4VR3	1902-3354	8	1	DIODE-ZNR 54.9V 5% DO-7 PD=.4W TC=+.081%	28480	1902-3354

Table 7-4. Replacement for A-5 Parts List

Reference Designator	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A5 (OPTION 704)	01345-66511	0	1	MEMORY BOARD	28480	01345-66511
A5C1	0180-0648	4	1	CAPACITOR-FXD 1UF±10% 35VDC TA	90201	TDC104K035NSE
A5C2	0160-3470	4	1	CAPACITOR-FXD 0.01 +80-20% 50VDC CER	28480	0160-3470
A5C3	0160-3456	6	1	CAPACITOR-FXD 1000PF ±10% 1KVDC CER	28480	0160-3456
A5C4	0160-2201	7	1	CAPACITOR-FXD 36PF ±5% 300VDC MICA	28480	0160-2201
A5C5	0160-2306	3	1	CAPACITOR-FXD 27PF ±300VDC MICA	28480	0160-2306
A5C6	0140-0208	8	1	CAPACITOR-FXD 680PF ±5% 300VDC MICA	72136	DM15F681J0300WV1CR
A5C7	0180-0229	7	1	CAPACITOR-FXD 33UF±10% 10VDC TA	56289	150D336X9010B2
A5C8	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A5C9	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A5C10	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A5C11	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A5C12	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A5C13	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A5C14	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A5C15	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A5C16	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A5C17	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A5C18	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A5C19	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A5C20	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A5C21	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A5C22	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A5C23	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A5C24	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A5C25	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A5C26	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A5C27	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A5C28	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A5C29	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A5C30	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A5C31	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A5C32	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A5C33	0140-0196	3		CAPACITOR-FXD 51PF 300V MI	28480	0140-0196
A5C34	0140-0206	6	1	CAPACITOR-FXD 270PF ±5% 500VDC MICA	28480	0140-0206
A5J2	1251-4322	1	2	CONNECTOR 3-PIN M POST TYPE	28480	1251-4322
A5J3	1251-4322	1		CONNECTOR 3-PIN M POST TYPE	28480	1251-4322
A5R1	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A5R2	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A5R3	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A5R4	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A5R5	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A5R6	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A5R7	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A5R8	0683-1245	5	1	RESISTOR 120K 5% .25W FC TC=-800/+900	01121	CB1245
A5R9	0683-1515	2	1	RESISTOR 150 5% .25W FC TC=-400/+600	01121	CB1515
A5R10	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A5R11	0683-2725	8	1	RESISTOR 2.7K 5% .25W FC TC=-400/+700	01121	CB2725
A5R12	0683-2025	1	1	RESISTOR 2K 5% .25W FC TC=-400/+700	01121	CB2025
A5R13	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A5R14	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A5U1	1820-1112	8	2	IC FF TTL LS D-TYPE POS-EDGE-TRIG	01295	SN74LS74AN
A5U2	1820-1405	6	1	IC SCHMITT-TRIG TTL LS NAND QUAD 2-INP	01295	SN74LS132N
A5U3	1820-1199	1	1	IC INV TTL LS HEX 1-INP	01295	SN74LS04N
A5U4	1820-0579	9	1	IC MV TTL LS MONOSTBL RETRIG DUAL	28480	1820-0579
A5U5	1820-1208	3	2	IC GATE TTL LS OR QUAD 2-INP	01295	SN74LS32N
A5U6	1820-1112	8		IC FF TTL LS D-TYPE POS-EDGE-TRIG	01295	SN74LS74AN
A5U7	1820-1433	6	1	IC SHF-RGTR TTL LS R-S SERIAL-IN PRL-OUT	01295	SN74LS164N
A5U8	1826-0180	0	1	IC TIMER TTL MONO/ASTBL	01295	NE555P
A5U9	1820-1470	1	3	IC MUXR/DATA-SEL TTL LS 2-TO-1-LINE QUAD	01295	SN74LS157N
A5U10	1820-1278	7	6	IC CNTR TTL LS BIN UP/DOWN SYNCHRO	01295	SN74LS191N
A5U11	1820-1278	7		IC CNTR TTL LS BIN UP/DOWN SYNCHRO	01295	SN74LS191N
A5U12	1820-1208	3		IC GATE TTL LS OR QUAD 2-INP	01295	SN74LS32N
A5U13	1820-1470	1		IC MUXR/DATA-SEL TTL LS 2-TO-1-LINE QUAD	01295	SN74LS157N
A5U14	1820-1278	7		IC CNTR TTL LS BIN UP/DOWN SYNCHRO	01295	SN74LS191N
A5U15	1820-1278	7		IC CNTR TTL LS BIN UP/DOWN SYNCHRO	01295	SN74LS191N
A5U16	1820-1201	6	1	IC GATE TTL LS AND QUAD 2-INP	01295	SN74LS08N
A5U17	1820-1449	4	1	IC GATE TTL S OR QUAD 2-INP	01295	SN74S32N
A5U18	1820-1281	2	1	IC DCDR TTL LS 2-TO-4-LINE DUAL 2-INP	01295	SN74LS139N
A5U19	1820-1470	1		IC MUXR/DATA-SEL TTL LS 2-TO-1-LINE QUAD	01295	SN74LS157N
A5U20	1820-1278	7		IC CNTR TTL LS BIN UP/DOWN SYNCHRO	01295	SN74LS191N
A5U21	1820-1278	7		IC CNTR TTL LS BIN UP/DOWN SYNCHRO	01295	SN74LS191N

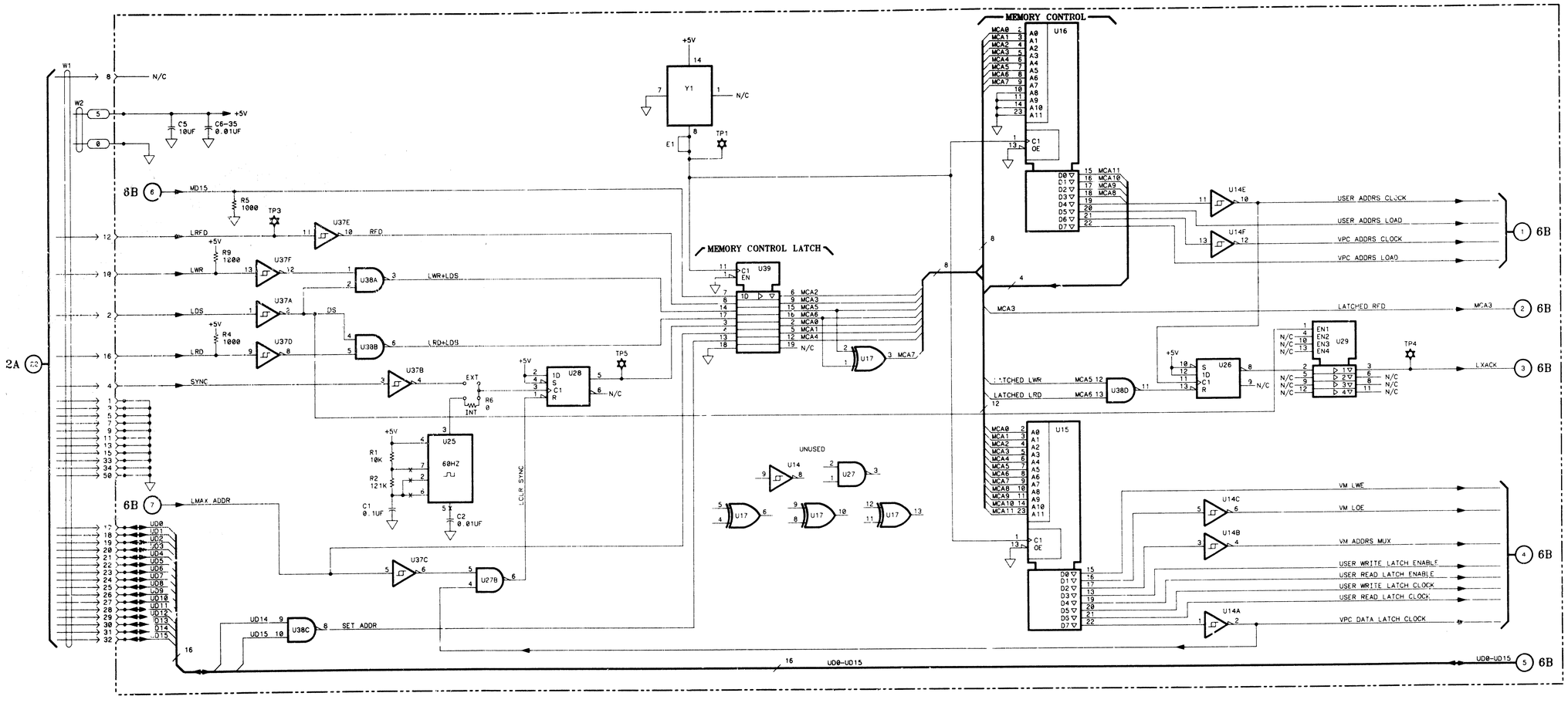
Table 7-4. Replacement for A-5 Parts List (Cont'd)

Reference Designator	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A5U22	1820-1197	9	2	IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
A5U23	1820-1568	8	1	IC BFR TTL LS BUS QUAD	01295	SN74LS126AN
A5U24	1820-2075	4	2	IC MISC TTL LS	01295	SN74LS245N
A5U25	1820-2075	4		IC MISC TTL LS	01295	SN74LS245N
A5U26	1818-1178	1	8	IC NMOS 8192 (8K) RAM STAT 200-NS	50088	MK4118N-3
A5U27	1818-1178	1		IC NMOS 8192 (8K) RAM STAT 200-NS	50088	MK4118N-3
A5U28	1818-1178	1		IC NMOS 8192 (8K) RAM STAT 200-NS	50088	MK4118N-3
A5U29	1818-1178	1		IC NMOS 8192 (8K) RAM STAT 200-NS	50088	MK4118N-3
A5U30	1818-1178	1		IC NMOS 8192 (8K) RAM STAT 200-NS	50088	MK4118N-3
A5U31	1818-1178	1		IC NMOS 8192 (8K) RAM STAT 200-NS	50088	MK4118N-3
A5U32	1818-1178	1		IC NMOS 8192 (8K) RAM STAT 200-NS	50088	MK4118N-3
A5U33	1818-1178	1		IC NMOS 8192 (8K) RAM STAT 200-NS	50088	MK4118N-3
A5U34	1820-1858	9	2	IC FF TTL LS D-TYPE OCTL	01295	SN74LS377N
A5U35	1820-1858	9		IC FF TTL LS D-TYPE OCTL	01295	SN74LS377N
A5U36	1820-1197	9		IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
A5W1	01345-61603	1		DATA CABLE	28480	01345-61603
A5W2	01345-61606	4		POWER CABLE	28480	01345-61606
A5XU26	1200-0541	1		SOCKET-IC 24-CONT DIP DIP-SLDR	28480	1200-0541
A5XU27	1200-0541	1		SOCKET-IC 24-CONT DIP DIP-SLDR	28480	1200-0541
A5XU28	1200-0541	1		SOCKET-IC 24-CONT DIP DIP-SLDR	28480	1200-0541
A5XU29	1200-0541	1		SOCKET-IC 24-CONT DIP DIP-SLDR	28480	1200-0541
A5XU30	1200-0541	1		SOCKET-IC 24-CONT DIP DIP-SLDR	28480	1200-0541
A5XU31	1200-0541	1		SOCKET-IC 24-CONT DIP DIP-SLDR	28480	1200-0541
A5XU32				NOT ASSIGNED		
A5XU33	1200-0541	1		SOCKET-IC 24-CONT DIP DIP-SLDR	28480	1200-0541

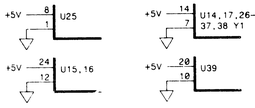
See introduction to this section for ordering information

Table 7-5. Replacement List of Manufacturing Codes

Mfr No.	Manufacturer Name	Address		Zip Code
00000	ANY SATISFACTORY SUPPLIER			
01121	ALLEN-BRADLEY CO	MILWAUKEE	WI	53204
01295	TEXAS INSTR INC SEMICOND CMPNT DIV	DALLAS	TX	75222
0192B	RCA CORP SOLID STATE DIV	SOMERVILLE	NJ	08876
02111	SPECTROL ELECTRONICS	CITY OF IND	CA	91745
03508	GE CO SEMICONDUCTOR PROD DEPT	SYRACUSE	NY	13201
03888	KDI PYROFILM CORP	WHIPPANY	NJ	07981
04713	MOTOROLA SEMICONDUCTOR PRODUCTS	PHOENIX	AZ	85062
07263	FAIRCHILD SEMICONDUCTOR DIV	MOUNTAIN VIEW	CA	94042
19701	MEPCO/ELECTRA CORP	MINERALS WELLS	TX	76067
24046	TRANSITRON ELECTRONIC CORP	WAKEFIELD	MA	01880
24546	CORNING GLASS WORKS (BRADFORD)	BRADFORD	PA	16701
27014	NATIONAL SEMICONDUCTOR CORP	PALO ALTO	CA	94304
27167	CORNING GLASS WORKS (WILMINGTON)	WILMINGTON	NC	28401
28480	HEWLETT-PACKARD CO CORPORATE HQ	PALO ALTO	CA	94304
30983	MEPCO/ELECTRA CORP	SAN DIEGO	CA	92121
32997	BOURNS INC TRIMPOT PROD DIV	RIVERSIDE	CA	92507
34371	HARRIS SEMICON DIV	MELBOURNE	FL	32901
50088	MOSTEK CORP	CARROLLTON	TX	75006
56289	SPRAGUE ELECTRIC CO	NORTH ADAMS	MA	01247
74100	BUSSMAN MFG DIV OF MCGRAW-EDISON CO	ST LOUIS	MO	63107
72136	ELECTRO MOTIVE CORP SUB IEC	WILLIMANTIC	CT	06226
72982	ERIE TECHNOLOGICAL PRODUCTS INC	ERIE	PA	16512
73138	BECKMAN INSTRUMENTS INC HELIPOT DIV	FULLERTON	CA	92634
75915	LITTLEFUSE INC	DES PLAINES	IL	60016
84411	TRW CAPACITOR DIV	OGALLALA	NE	69153
91506	AUGAT INC	ATTLEBORO	MA	02703



IC DEVICE POWER CONNECTIONS



NOTES:

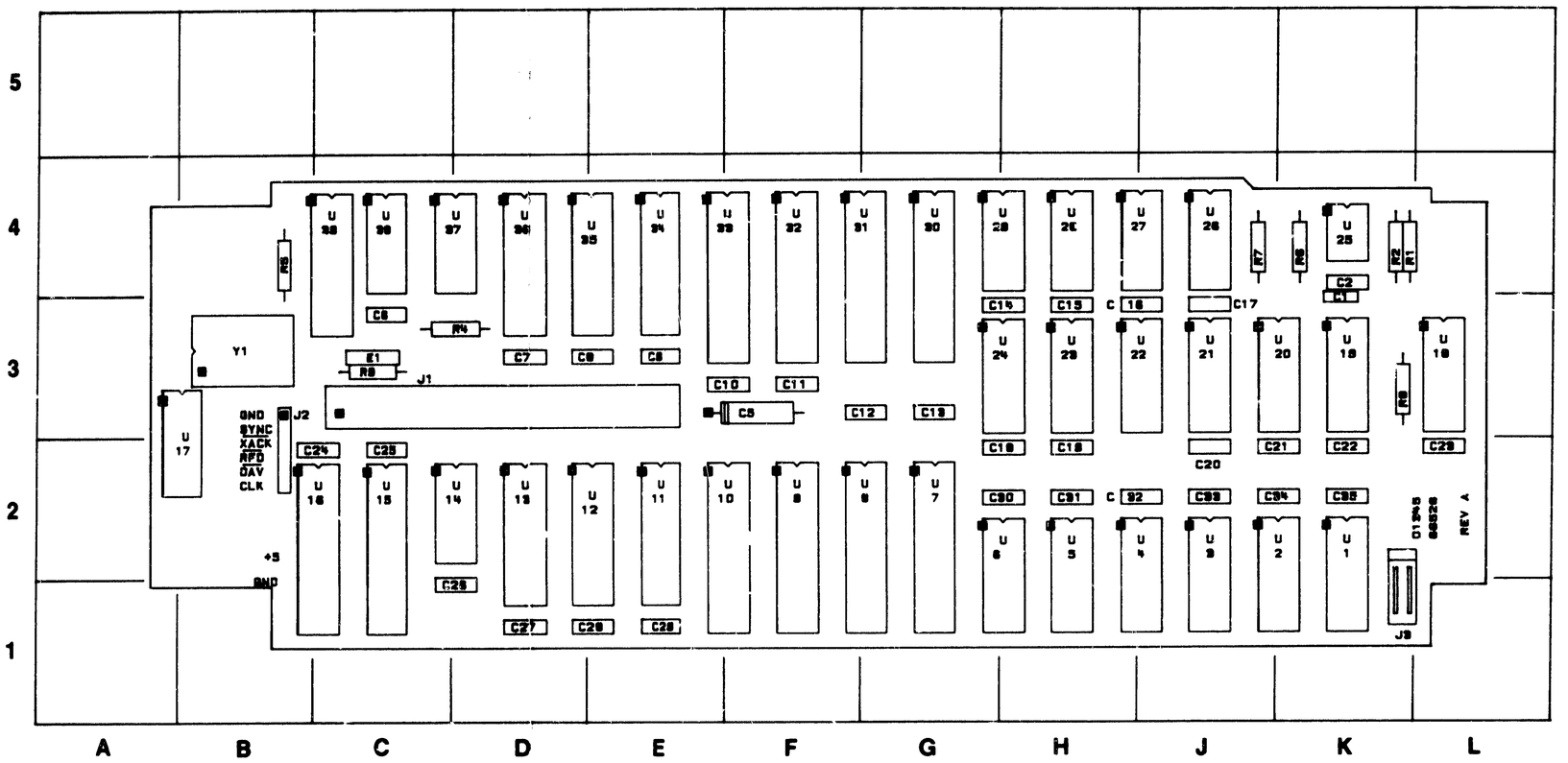
1. GATES ARE SYMBOLIZED ACCORDING TO CIRCUIT FUNCTION.
2. UNLESS OTHERWISE NOTED:
 RESISTANCE IN OHMS
 CAPACITANCE IN PICOFARADS
 INDUCTANCE IN MICROHENRIES
3. UNLESS OTHERWISE NOTED:
 LOGIC LEVELS ARE TTL:
 +2 0V TO +5.0V=LOGIC"1"=H
 0V TO +0.8V=LOGIC"0"=L

PARTS ON THIS SCHEMATIC	
A5	CHASSIS
C1,C2,C5-35 E1 R1,2,4-6,9 U14-17,25-29,37-39 W1,W2 Y1	

S1345056/2-20-85

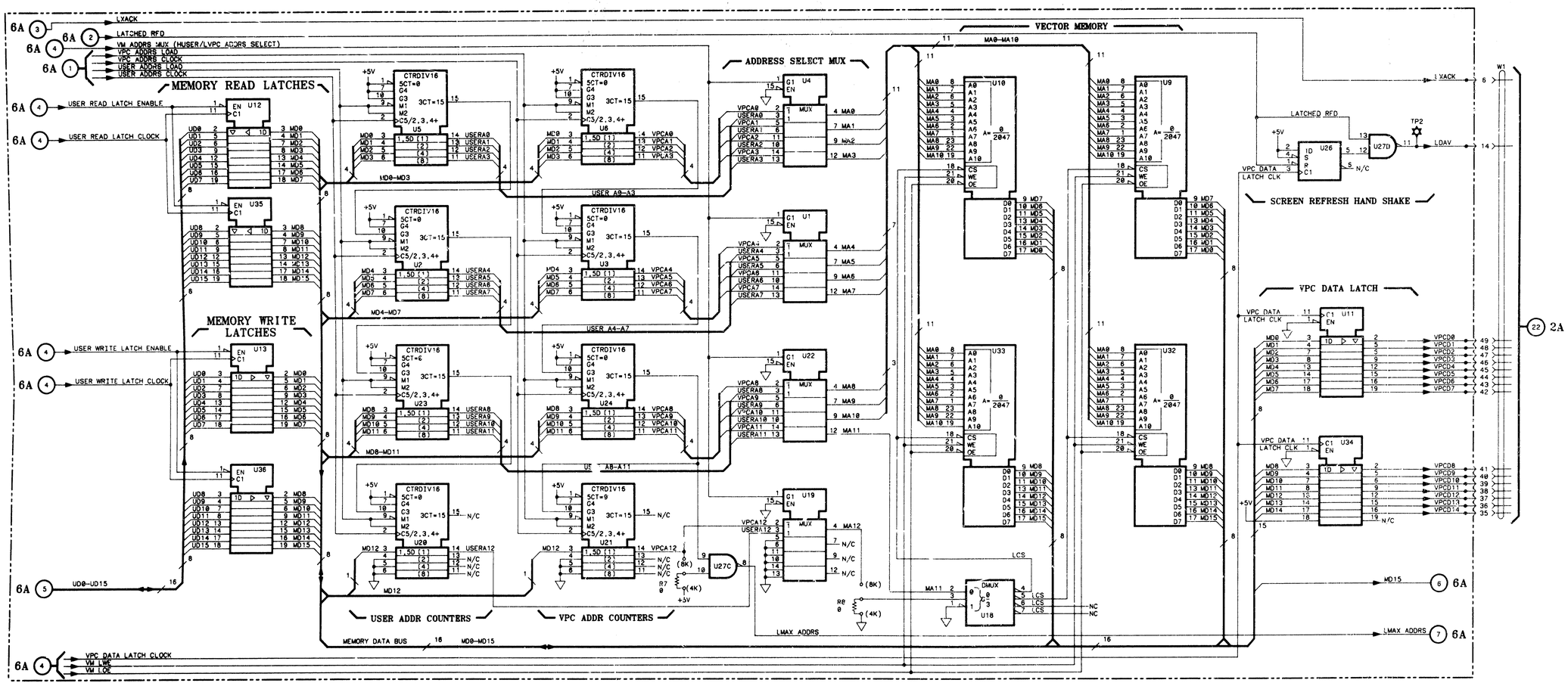
6A

Figure 8-15.
Service Sheet 6A, Memory (Option 704, A5)



REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC
C1	K-3	C25	C-2	R8	K-3	U20	J-3
C2	K-4	C26	C-1	R9	C-3	U21	J-3
C5	F-3	C27	D-1	U1	K-2	U22	H-3
C6	C-3	C28	D-1	U2	J-2	U23	H-3
C7	D-3	C29	E-1	U3	J-2	U24	G-3
C8	D-3	C30	G-2	U4	H-2	U25	K-4
C9	E-3	C31	H-2	U5	H-2	U26	J-4
C10	E-3	C32	H-2	U6	G-2	U27	H-4
C11	F-3	C33	J-2	U7	G-2	U28	H-4
C12	F-3	C34	J-2	U8	F-2	U29	G-4
C13	G-3	C35	K-2	U9	F-2	U30	G-4
C14	G-3	E1	C-3	U10	E-2	U31	F-4
C15	H-3	J1	C-3	U11	E-2	U32	F-4
C16	H-3	J2	B-3	U12	D-2	U33	E-4
C17	J-3	J3	K-1	U13	D-2	U34	E-4
C18	G-2	R1	K-4	U14	C-2	U35	D-4
C19	H-2	R2	K-4	U15	C-2	U36	D-4
C20	J-2	R4	C-3	U16	B-2	U37	C-4
C21	J-2	R5	B-4	U17	A-2	U38	C-4
C22	K-2	R6	K-4	U18	L-3	U39	C-4
C23	L-2	R7	J-4	U19	K-3	Y1	B-3
C24	B-2						

P/O Service Sheet 6, Memory (Option 704, A5)



IC DEVICE POWER CONNECTIONS

+5V pin 16	U1-6, 8, 18-24	+5V pin 14	U26,27 pin 7
+5V pin 24	U7-10, 12, 30-33	+5V pin 20	U11-13, 8, 34-36

NOTES:

1. GATES ARE SYMBOLIZED ACCORDING TO CIRCUIT FUNCTION.
2. UNLESS OTHERWISE NOTED:
 RESISTANCE IN OHMS
 CAPACITANCE IN PICOFARADS
 INDUCTANCE IN MICROHENRIES
3. UNLESS OTHERWISE NOTED:
 LOGIC LEVELS ARE TTL:
 +2.0V TO +5.0V=LOGIC"1"=H
 0V TO +0.8V=LOGIC"0"=L

PARTS ON THIS SCHEMATIC	
A5	CHASSIS
R7,8 U1-13,18-24,26, 27C,27D,30-36	W1

S1345058/2-22-85

6B

Figure 8-16.
Service Sheet 6B, Memory (Option 704, A5)

MANUAL CHANGES

MANUAL IDENTIFICATION

Model Number: 1345A

Date Printed: March 1985

Part Number: 01345-90916

This supplement contains important information for correcting manual errors and for adapting the manual to instruments containing improvements made after the printing of the manual.

To use this supplement:
Make all ERRATA corrections.
Make all appropriate serial number related changes indicated in the tables.

Serial Prefix or Number	Make Manual Changes	Serial Prefix or Number	Make Manual Changes
2605A	1		
2619A	1, 2		

▶ NEW ITEM

ERRATA

SECTION VI, REPLACEABLE PARTS
Table 6-2, Replaceable Parts
Change: MP6 (SHIELD-SUP SUB ASSY); HP and Mfr. Part Nos. to 01345-60607; CD to 3.
Add: MP106 (BAND-CRT); HP and Mfr. Part Nos. 01345-00602; CD 2; QTY 1; Mfr. Code 28480.
Add: MP107 (BUMPER); HP and Mfr. Part Nos. 0403-0490; CD 8; QTY 4; Mfr. Code 28480.
Add: MP108 (CLAMP-HOSE); HP and Mfr. Part Nos. 1400-0026; CD 1; QTY 2; Mfr. Code 28480.
Change: A2C3 to (CAPACITOR-FXD 10UF ±10% 20VDC TA); HP and Mfr. Part Nos. 0180-0374; CD 3; QTY 1; Mfr. Code 28480.

SECTION VIII, SERVICE
Service Sheet 2A, P/O Vector Processor Change: C3 value to 10UF.

NOTE

Manual change supplements are revised as often as necessary to keep manuals as current and accurate as possible. Hewlett-Packard recommends that you periodically request the latest edition of this supplement. Free copies are available from all HP offices. When requesting copies quote the manual identification information from your supplement, or the model number and print date from the title page of the manual.

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CHANGE 1

SECTION VI, REPLACEABLE PARTS
Table 6-2, Replaceable Parts
Change: A5 (MEMORY BOARD); HP and Mfr. Part Nos to 01345-66533, 2 places.
Change: A5U15 (IC PAL20R8A PMGD); HP and Mfr. Part Nos to 01345-80005.

SECTION VIII, SERVICE
Service Sheets 6A and 6B, Memory (Option 7C4, A5).

Modify Service Sheets 6A and 6B as shown in figure 2 of this Change Sheet.

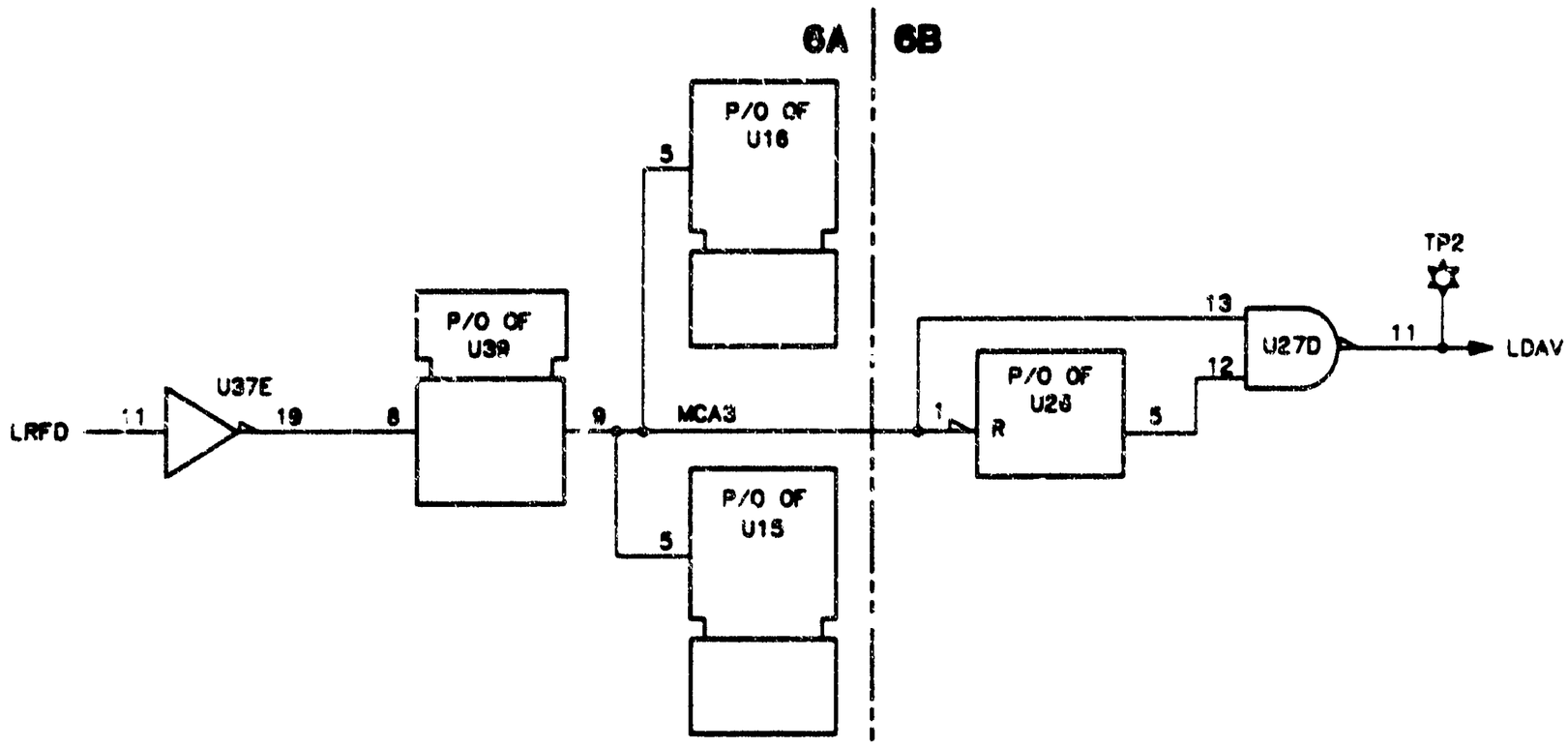


Figure 1. Old Memory Circuit.

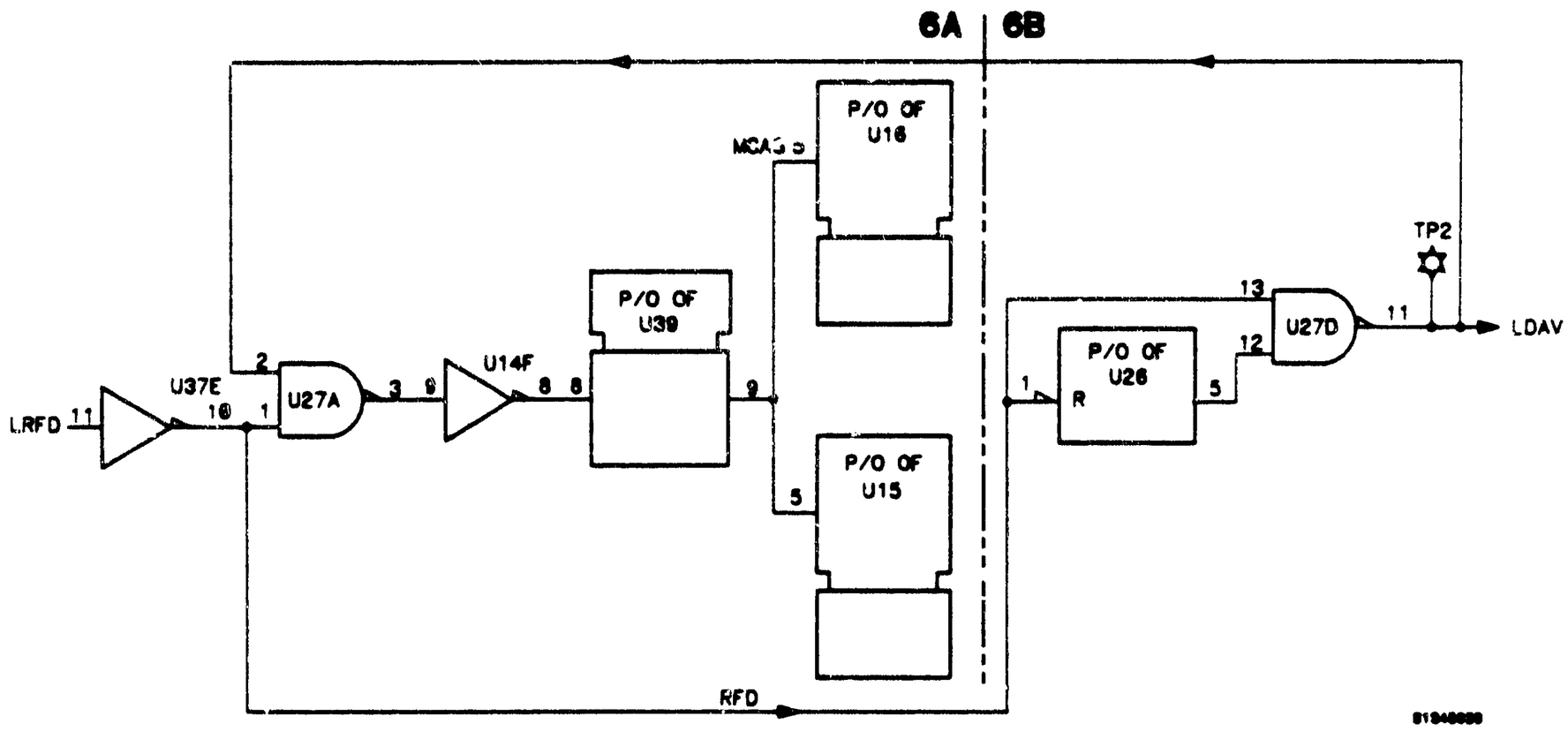


Figure 2. Changes to Memory Circuit.

▶ CHANGE 2

SECTION VI, REPLACEABLE PARTS

Table 6-2, Replaceable Parts

Change: A4 (HIGH VOLTAGE POWER SUPPLY) HP and Mfr. Part Nos to 01345-66534 (2 places).

Change: A4A1 (HIGH VOLTAGE MULTIPLIER) HP and Mfr. Part Nos. to 0960-0734.